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UNDERWATER SHOCK ANALYSIS OF NONLINEAR STRUCTURES, A REFERENCE MANUAL FOR THE USA-STAGS CODE (VERSION 3)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a reference manual for the third version of the USA-STAGS Code that calculates the nonlinear transient response of a totally or partially submerged structure to a spherical shock wave of arbitrary pressure profile and source location. USA-STAGS is the result of interfacing USA (Underwater Shock Analysis) and STAGS (Stress Analysis of General Shells). The fluid is assumed to be an infinite acoustic medium whose response to motions of the structure is described by either of the Doubly Asymptotic Approximations, DAA_1 or DAA_2.

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SUMMARY

This report is a reference manual for the third version of the USA-STAGS Code that calculates the nonlinear transient response of a totally or partially submerged structure to a spherical shock wave of arbitrary pressure profile and source location. USA-STAGS is the result of interfacing USA (Underwater Shock Analysis) and STAGS (Stress Analysis of General Shells). The fluid is assumed to be an infinite acoustic medium whose response to motions of the structure is described by either of the Doubly Asymptotic Approximations, DAA_1 or DAA_2.

PREFACE

The authors express their appreciation to B. O. Almroth and Dr. T. L. Geers for sowing the seeds which eventually led to the realization of the USA-STAGS Code and to Dr. C. A. Felippa who has provided both time and software to this effort.

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SECTION I

INTRODUCTION

This report is a reference manual for the third version of the USA-STAGS Code that calculates the nonlinear transient response of a totally or partially submerged structure to a spherical shock wave of arbitrary pressure profile and source location. This constitutes a revision of [1], the original manual that describes the interfacing of USA (Underwater Shock Analysis) [2], and STAGS (STress Analysis of General Shells) [3].

The USA Code computes the transient response of a totally or partially submerged, shock-wave-excited elastic structure using a linear (or linearized) stiffness matrix that has been constructed by a finite-element or finite-difference structural analyzer of choice. STAGS is a general-purpose nonlinear finite-element, structural code that is very efficient for the analysis of inelastic collapse of stiffened shell structures. USA-STAGS employs the staggered solution strategy upon which USA itself is constructed. In this procedure the structural response equations and the fluid response equations are solved separately, step-by-step, through extrapolation of terms which couple the two systems thus preserving the modularity of each code. This technique has been shown to be unconditionally stable with respect to time step size in the linear response problem [4].

The fluid equations treated by USA-STAGS apply to an infinite or semi-infinite acoustic medium and either the Doubly Asymptotic Approximation (DAA_1) or the Improved Doubly Asymptotic Approximation (DAA_2) [5, 6] is used to determine the fluid pressure on the "wet" surface of the structure.

The following additions, changes and enhancements have been incorporated in the USA-STAGS Code since [1] was issued:

1) STAGS C-1 has become the standard version for underwater shock analysis.

2) An imaging formulation that allows the analysis of problems involving partially submerged structures and structures totally submerged near the free surface has been implemented.

3) A technique has been developed to include the effects of bulk cavitation in the incident wave excitation that provides a complete description of fluid particle velocity consistent with the occurrence of surface cutoff.

4) Surface-of-revolution fluid elements can now treat both beam-like and bar-like response.

5) The Improved Doubly Asymptotic Approximation (DAA_2) is now operational.

6) The fluid equation system is processed in an out-of-core mode to allow substantial increases in the allowable number of fluid elements.

7) A capability to do linear analysis has been built into the USA-STAGS Code.

8) An improvement has been added to the integration time step control to allow STAGS to change the step size if required for convergence.

9) A hydrostatic prestress analysis of the structure can be made to provide non-zero initial values for nonlinear underwater shock analysis.

10) A capability to conduct a collapse analysis of the structure upon completion of the transient analysis has been added.

11) USA-STAGS is now operational on the VAX 11/780 virtual memory system machine.

1.1 STAGGERED SOLUTION PROCEDURE

USA-STAGS is constructed around the staggered solution procedure which avoids the simultaneous solution of the structural response equations and the fluid response equations. Such a simultaneous solution would be costly from two viewpoints. First, a special-purpose version of STAGS would have been required. Second, the computation time would have been substantially increased over that required for the transient analysis of a dry structure due to the widespread coupling induced by the fluid.

On the other hand, the staggered solution procedure involves a response extrapolation at each time step, which usually leads to numerical instability for time increments exceeding a critical value. Because this critical value may be unacceptably small for some computations, the fluid equations used in USA have been modified in such a way that unconditional stability has been achieved for the linear elastic structural response problem [4].

At this time an investigation of time step stability of the coupled USA-STAGS system has not been performed. Stability will depend not only upon the specific types of nonlinearity inherent in the STAGS equations but also upon which of the family of STAGS integration algorithms is used in any particular case. It is likely, however, that unconditional stability will exist for some range of mildly nonlinear behavior.

1.2 DOUBLY ASYMPTOTIC APPROXIMATIONS

The DAA_1 is embodied in a linear first order matrix ordinary differential equation that defines the fluid pressure due to the scattered wave at the fluid-structure boundary. The principal advantage of the DAA_1 then is that it models the infinite acoustic medium surrounding the structure as a membrane covering the wet surface of the struc-

ture. Hence fluid motion is described merely in terms of wet-surface response variables, which are then linked by compatibility relations to the structural response variables.

The principal disadvantage of the DAA_1 is that it constitutes an approximation to the "exact" boundary-element representation of the surrounding medium [7,8]. The DAA_1 does approach exactness for both high-frequency (early-time) and low-frequency (late-time) structural motions, however, and effects a smooth transition between the two asymptotes. In addition, it has exhibited satisfactory accuracy in a variety of check calculations [6,7,9].

The DAA_2 is an improved approximation that is based upon the DAA_1; however, it can describe the intermediate frequency range better than the DAA_1 because it is a second order matrix differential equation. Computationally it has been used to study the response of the infinite cylindrical shell under a plane wave step loading in which significant improvements in accuracy have been noted [2]. Analytical studies of spherical shell response [6] also show such marked improvement.

Although the DAA_1 and DAA_2 have been shown to be suitable for engineering analysis of underwater shock problems, the physics of such problems still include features of great complexity not currently treated. For example, local fluid cavitation at the fluid-structure interface may substantially alter structural response for incident shock waves of short duration. Effective means of including hull cavitation phenomena in the numerical solution of underwater shock problems are still being sought.

1.3 USA FEATURES

A number of special features are incorporated in the USA code. First, a capability has been provided to handle a fluid mesh on the wet surface that is not coincident with the surface mesh for the structural model. This permits, for example, the use of a refined structural mesh in a region of high stress gradients, even though a relatively coarse mesh is retained for the fluid.

Second, options for variable-increment time integration and computation restart are furnished. The former allows the use of small time increments during periods where the response is expected to be varying rapidly in time, and the use of large time increments for periods characterized by a slowly varying response. The latter permits the division of a response computation into segments, so that the analyst may examine the results at selected points along the way. Such examination is facilitated by the use of the "printer-plot" routine that augments the usual printout data with response plots "drawn" by the printer.

Third, the code incorporates fluid boundary elements for both general and body-of-revolution wet-surface geometries [10]. This feature is especially useful for compartment-by-compartment analysis of a submarine. Such an analysis utilizes a general-structure discrete-element model of a particular compartment of interest, with the remainder of the submarine modeled as a bar/beam. Hence a detailed analysis of an entire submarine may be performed with several discrete-element models of moderate size, avoiding the use of a single gigantic model.

Fourth, the analyst can use either the DAA_1 or DAA_2 through input of a single scalar parameter to take advantage of the enhanced accuracy demonstrated by the latter in computations for idealized geometries.

Fifth, out-of-core processing for both the structural <u>and</u> fluid equation systems frees the user from concern over core limitations on the number of structural and fluid elements in his model.

Sixth, free-field shock wave input to the structure is associated with a spherical wave for both submerged and partially submerged structures and can be input for use with linear interpolation or cubic spline fitting routines. Pressure hisories for exponentially decaying incident waves can be automatically generated. Fluid pressure and particle velocity histories corresponding to the input shock are displayed for the user with the "printer-plot" software mentioned above.

Seventh, the effects of bulk cavitation on the free field pressure history are approximately treated.

1.4 STAGS FEATURES

STAGS is primarily intended for the nonlinear analysis of shell structures; therefore, great emphasis has been placed on computational efficiency. The capabilities of STAGS include the following processors: 1) linear stress analysis; 2) geometrically nonlinear elastic stress analysis; 3) inelastic stress analysis, geometrically linear or nonlinear; 4) bifurcation buckling analysis with linear or geometrically nonlinear prestress (elastic); 5) small vibration analysis with prestress based on linear or geometrically nonlinear analysis (elastic); and 6) transient response analysis, linear or geometrically nonlinear, elastic or inelastic. In a STAGS analysis, the structure can be defined as composed of a number of shell branches. Linear springs (axial or torsional) and nonlinear general beam elements also can be included. If the beams are defined as stiffeners attached to the shell along a line on its surface, appropriate displacement constraints will be enforced automatically. Loading is either mechanical (forces or forced displacements) or thermal. Any boundary conditions or other displacement constraints are permitted as long as they are linear. Displacement-dependent hydrostatic loads may be used. For transient problems, velocity-dependent damping may be included in specified regions. General damping proportional to mass or linear stiffness may also be selected.

A number of quadrilateral and triangular finite-elements are available as options for discretization of the shell branches. The discretization procedures available include a flat element in which lateral displacements are bicubic and in-plane displacements at least quadratic. At each corner node, there are six or seven degrees of freedom: three displacement components, three rotation components, and optionally the shear strain. In addition, displacements along the element boundaries may be included as degrees of freedom at midpoint nodes, thus the maximum number of degrees of freedom per element is 32. Refined quadrilateral elements constructed from sub-triangles may also be used. These quadrilaterals need not be flat.

Bifurcation buckling and small vibration analyses lead to linear eigenvalue problems. In STAGS, these are solved through the generation of invariant subspaces by simultaneous power iteration [11]. Nonlinear static analysis results in nonlinear algebraic equations. For solution of such equations, the STAGS user has the options of using either the modified or the regular Newton method [12]. For transient analysis numerical integration the following options are available: 1) the central difference scheme; 2) trapezoidal rule; 3) Gear's two- and three-order methods; or 4) Park's method. A discussion of these methods is available in Ref. [13].

1.5 SPECIAL NON-FEATURES

Some features of modest complexity have yet to be incorporated into the USA-STAGS Code. First, an option for automatic time-step integration would free the analyst from having to select integration time increments in accordance with his expectations regarding response behavior. Second, the ability to handle very large problems would be useful in those cases where structural segmentation is not possible. Third, a capability to treat banded structural mass and damping matrices would be helpful, in order to accommodate structural elements that produce such matrices. Fourth, a means to handle the matrices produced by acoustic elements based on a pressure formulation [14,15] is desirable, in that such elements permit highly efficient modeling of internal fluid volumes.

An important feature of greater complexity has yet to be introduced into the code. This is a treatment of hull cavitation, which may substantially affect structural response for incident shock waves of short duration. The introduction of this feature requires the accurate treatment of highly nonlinear phenomena, and presents a challenging task for future work.

SECTION II

FLUID-STRUCTURE INTERACTION PROBLEM FORMULATION AND SOLUTION PROCEDURE

This section describes the theoretical foundation of the USA-STAGS Code; and is constructed as an overview, with coverage of details left to referenced papers and reports.

2.1 STRUCTURAL RESPONSE EQUATION

The discretized differential equation system for the dynamic response of a nonlinear structure can be expressed in the form

$$\underset{\sim}{M}_s \ddot{\underline{x}} + \underset{\sim}{C}_s \dot{\underline{x}} + \underset{\sim}{K}_s \underline{x} = \underline{f} \tag{2.1}$$

where $\underline{x}$ is the structural displacement vector, $\underset{\sim}{M}_s$, $\underset{\sim}{C}_s$ and $\underset{\sim}{K}_s$ are the nonlinear structural mass, damping and stiffness operators, respectively, $\underline{f}$ is the external force vector, and a dot denotes a temporal derivative. Generally, $\underset{\sim}{M}_s$, $\underset{\sim}{C}_s$ and $\underset{\sim}{K}_s$ are highly banded, symmetric operators of large order; at present the USA-STAGS Code considers $\underset{\sim}{M}_s$ to be diagonal and $\underset{\sim}{C}_s$ to be a linear combination of $\underset{\sim}{M}_s$ and the linear portion of $\underset{\sim}{K}_s$.

For excitation of a submerged structure by an acoustic wave, $\underline{f}$ is given by

$$\underline{f} = -\underset{\sim}{G} \underset{\sim}{A}_f (\underline{p}_I + \underline{p}_S) + \underline{f}_D \tag{2.2}$$

where $\underline{p}_I$ and $\underline{p}_S$ are nodal pressure vectors for the wet-surface fluid mesh pertaining to the (known) incident wave and the (unknown) scattered wave, respectively, $\underline{f}_D$ is the dry-structure applied force vector, $\underset{\sim}{A}_f$ is the diagonal area matrix associated with elements in the fluid mesh, and $\underset{\sim}{G}$ is the transformation matrix that relates the structural and fluid nodal surface forces. More will be said about $\underset{\sim}{G}$ in the next subsection.

2.2 DAA_1 EQUATION

The Doubly Asymptotic Approximation may be written [5,6]

$$\underset{\sim}{M}_f \dot{\underline{p}}_S + \rho c \underset{\sim}{A}_f \underline{p}_S = \rho c \underset{\sim}{M}_f \dot{\underline{u}}_S \tag{2.3}$$

where $\underline{u}_S$ is the vector of scattered-wave fluid-particle velocities normal to the structure's wet surface, ρ and c are the density and sound velocity of the fluid, respectively, and $\underset{\sim}{M}_f$ is the symmetric fluid mass matrix for the wet-surface fluid mesh. This matrix is produced by a boundary-element treatment of Laplace's equation for the irrotational flow generated in an infinite, inviscid, incompressible fluid

by motions of the structure's wet surface; it is fully populated with non-zero matrix elements. When transformed into structural coordinates, the fluid mass matrix yields the added mass matrix, which, when combined with the structural mass matrix, yields the virtual mass matrix for motions of a structure submerged in an incompressible fluid [16].

As mentioned in Section I, the approximate relation (2.3) is called "doubly asymptotic" because it approaches exactness in both the high-frequency (early-time) and low-frequency (late-time) limits. For high-frequency motions, $|\dot{\underline{p}}_S| \gg |\underline{p}_S|$, so that (2.3) approaches the relation $\underline{p}_S = \rho c \underline{u}_S$, which is the correct limit for short acoustic wavelengths. For low-frequency motions, $|\dot{\underline{p}}_S| \ll |\underline{p}_S|$, so that (2.3) approaches the incompressible-flow relation $\underset{\sim}{A}_f\, \underline{p}_S = \underset{\sim}{M}_f\, \dot{\underline{u}}_S$, which is the correct limit for long acoustic wavelengths.

For excitation by an incident acoustic wave, $\underline{u}_S$ is related to structural response by the kinematic compatibility relation

$$\underset{\sim}{G}^T \dot{\underline{x}} = \underline{u}_I + \underline{u}_S \tag{2.4}$$

where the superscript "T" denotes matrix transposition. Equation (2.4) expresses the constraint that normal fluid-particle velocity match normal structural velocity on the wet surface of the structure. The fact that the transformation matrix relating those velocities is $\underset{\sim}{G}^T$ follows from the invariance of virtual work with respect to either of the wet surface coordinate systems. Generally, $\underset{\sim}{G}$ is a rectangular matrix whose height greatly exceeds its width, inasmuch as the number of structural DOF usually exceeds considerably the number of fluid DOF.

2.3 INTERACTION EQUATIONS

The introduction of (2.2) into (2.1) and (2.4) into (2.3) yields the interaction equations

$$\begin{aligned} \underset{\sim}{M}_s\, \ddot{\underline{x}} + \underset{\sim}{C}_s\, \dot{\underline{x}} + \underset{\sim}{K}_s\, \underline{x} &= -\underset{\sim}{G}\, \underset{\sim}{A}_f\, (\underline{p}_I + \underline{p}_S) \\ \underset{\sim}{M}_f\, \dot{\underline{p}}_S + \rho\, c\, \underset{\sim}{A}_f\, \underline{p}_S &= \rho\, c\, \underset{\sim}{M}_f\, (\underset{\sim}{G}^T \ddot{\underline{x}} - \dot{\underline{u}}_I) \end{aligned} \tag{2.5}$$

These equations may be solved simultaneously at each time step by the transfer of $-\underset{\sim}{G}\, \underset{\sim}{A}_f\, p_S$ and $\rho\, c\, \underset{\sim}{M}_f\, \underset{\sim}{G}^T\, \ddot{\underline{x}}$ to the left sides of their respective equations. Such a procedure is exceedingly expensive, however, because of the large connectivity of the coefficient matrix involved. As mentioned in Section I, efficient computation is possible through the application of a staggered solution procedure that is unconditionally stable with respect to the choice of time increment, at least in the linear case.

The simplest implementation of the staggered solution procedure recommended in [4] may be effected as follows. $\underset{\sim}{M}_s$ is taken to be diagonal and, to allow for the possibility that $\underset{\sim}{M}_s$ may have zero entries for rotational DOF, $\underset{\sim}{G}$ is constructed such that only the transla-

tional DOF for the structure couple with the fluid DOF [see (2.4)]; then the first of (2.5) may be partitioned to obtain $\underset{\sim}{G}^T\ddot{\underline{x}}$, which may then be introduced into the second of (2.5). Premultiplication of the resulting equation by $\frac{1}{\rho c}\underset{\sim}{A}_f\underset{\sim}{M}_f^{-1}$ then yields

$$\frac{1}{\rho c}\underset{\sim}{A}_f\dot{\underline{p}}_S + (\underset{\sim}{D}_{f1} + \underset{\sim}{D}_s)\underline{p}_S = -\underset{\sim}{A}_f\underset{\sim}{G}^T\underset{\sim}{M}_s^{-1}(\underset{\sim}{C}_s\dot{\underline{x}} + \underset{\sim}{K}_s\underline{x}) - (\underset{\sim}{D}_s\underline{p}_I + \underset{\sim}{A}_f\dot{\underline{u}}_I) \tag{2.6}$$

where $\underset{\sim}{D}_{f1} = \underset{\sim}{A}_f\underset{\sim}{M}_f^{-1}\underset{\sim}{A}_f$ and $\underset{\sim}{D}_s = \underset{\sim}{A}_f\underset{\sim}{G}^T\underset{\sim}{M}_s^{-1}\underset{\sim}{G}\underset{\sim}{A}_f$ are symmetric, and where $\underset{\sim}{M}_s^{-1}$ is a diagonal matrix with each nonzero element given as the reciprocal of the corresponding nonzero element of $\underset{\sim}{M}_s$ and each zero element mirroring the corresponding zero element of $\underset{\sim}{M}_s$. The first of (2.5) and (2.6) are herein termed "the augmented interaction equations".

2.4 SPHERICAL INCIDENT WAVE

Each element of the vectors $\underline{p}_I$ and $\dot{\underline{u}}_I$ for a spherical incident wave are given by

$$\begin{aligned} p_{Ii}(t) &= \frac{S}{R_i}\, p_I\left(t - \frac{R_i - S}{c}\right) \\ \dot{u}_{Ii}(t) &= \left[\frac{1}{\rho c}\dot{p}_{Ii}(t) + \frac{1}{\rho R_i}p_{Ii}(t)\right]\gamma_i \end{aligned} \tag{2.7}$$

where S is the "charge standoff", i.e., the distance between the origin of the incident spherical wave and the nearest point on the structure's wet surface, R_i is the distance from the origin of the incident spherical wave to the $i\underline{th}$ fluid node on the wet surface, γ_i is the cosine of the angle between the vector corresponding to R_i and the wet-surface normal at the $i\underline{th}$ fluid node, and $p_I(t)$ is the incident-wave pressure-profile defined at $R_i = S$. For a shock wave, $p_I(t)$ is discontinuous at $t = 0$ and the $\dot{u}_{Ii}(t)$ contain singularities.

In order to remove shock-wave singularities from $\dot{\underline{u}}_I$ in (2.6), a modified pressure vector is defined as

$$\underline{p}_M = \underset{\sim}{\Gamma}\underline{p}_I + \underline{p}_S \tag{2.8}$$

where $\underset{\sim}{\Gamma}$ is a diagonal matrix with direction-cosine elements γ_i. The introduction of (2.8) into (2.6) and the first of (2.5), followed by utilization of the second of (2.7) then yields the modified, augmented, interaction equations

$$\begin{aligned} \underset{\sim}{M}_s\ddot{\underline{x}} + \underset{\sim}{C}_s\dot{\underline{x}} + \underset{\sim}{K}_s\underline{x} &= -\underset{\sim}{G}\underset{\sim}{A}_f\left[\underline{p}_M + (\underset{\sim}{I} - \underset{\sim}{\Gamma})\underline{p}_I\right] \\ \frac{1}{\rho c}\underset{\sim}{A}_f\dot{\underline{p}}_M + (\underset{\sim}{D}_{f1} + \underset{\sim}{D}_s)\underline{p}_M &= -\underset{\sim}{A}_f\underset{\sim}{G}^T\underset{\sim}{M}_s^{-1}(\underset{\sim}{C}_s\dot{\underline{x}} + \underset{\sim}{K}_s\underline{x}) - \underset{\sim}{H}\underline{p}_I \end{aligned} \tag{2.9}$$

in which $\underset{\sim}{I}$ is the identity matrix, and

$$\underset{\sim}{H} = \underset{\sim}{D}_s - (\underset{\sim}{D}_s + \underset{\sim}{D}_{f1} - \frac{1}{\rho} \underset{\sim}{A}_f \underset{\sim}{R}^{-1}) \underset{\sim}{\Gamma} \qquad (2.10)$$

where $\underset{\sim}{R}$ is the diagonal matrix formed by the distances R_i. Equations (2.9) are the equations solved by the USA-STAGS to determine the structural responses $\underline{x}$ and $\dot{\underline{x}}$, and the wet-surface pressures $\underline{p} = (\underset{\sim}{I} - \underset{\sim}{\Gamma}) \underline{p}_I + \underline{p}_M$.

2.5 FREE SURFACE EFFECTS

When a structure is partially submerged, or when a totally submerged structure lies near the free surface of a semi-infinite fluid, imaging techniques may be utilized to ensure that the total pressure vanishes at the free surface. (This implies that the effects of gravity are negligible in this class of problems, which they generally are.) In this case, the interactive system consists of an infinite fluid domain, the structure S_+, and its image S_- (see Figure 2-1). The incident wave now consists of a (positive) primary wave plus a (negative) image wave, the latter emanating from the image of the primary wave's origin. Zero pressure at the free surface is therefore maintained if the motions of S_- are constrained to be opposite to those of S_+.

The kinetic energy T_s, the Rayleigh dissipation function D_s, the potential energy V_s, and the work potential Π_s, for the structural system $S_+ + S_-$ are given by

$$\begin{aligned}
T_s &= \tfrac{1}{2} (\dot{\underline{x}}_+^T \underset{\sim}{M}_s \dot{\underline{x}}_+ + \dot{\underline{x}}_-^T \underset{\sim}{M}_s \dot{\underline{x}}_-) \\
D_s &= \tfrac{1}{2} (\dot{\underline{x}}_+ \underset{\sim}{C}_s \dot{\underline{x}}_+ + \dot{\underline{x}}_-^T \underset{\sim}{C}_s \dot{\underline{x}}_-) \\
V_s &= \tfrac{1}{2} (\underline{x}_+^T \underset{\sim}{K}_s \underline{x}_+ + \underline{x}_-^T \underset{\sim}{K}_s \underline{x}_-) \\
\Pi_s &= -\underline{x}_+^T \underline{f}_+ - \underline{x}_-^T \underline{f}_-
\end{aligned} \qquad (2.11)$$

The appropriate constraints are $\underline{x}_- = -\underline{x}_+$ and $\underline{f}_- = -\underline{f}_+$, so that (2.11) become

$$\begin{aligned}
T_s &= \dot{\underline{x}}_+^T \underset{\sim}{M}_s \dot{\underline{x}}_+ \\
D_s &= \dot{\underline{x}}_+^T \underset{\sim}{C}_s \dot{\underline{x}}_+ \\
V_s &= \underline{x}_+^T \underset{\sim}{K}_s \underline{x}_+ \\
\Pi_s &= -2 \underline{x}_+^T \underline{f}_+
\end{aligned} \qquad (2.12)$$

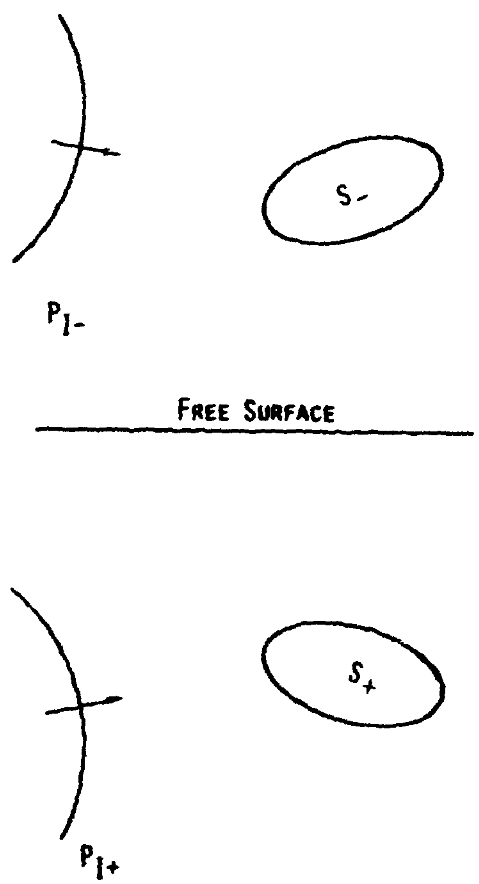

Figure 2-1 Image Technique for Free Surface

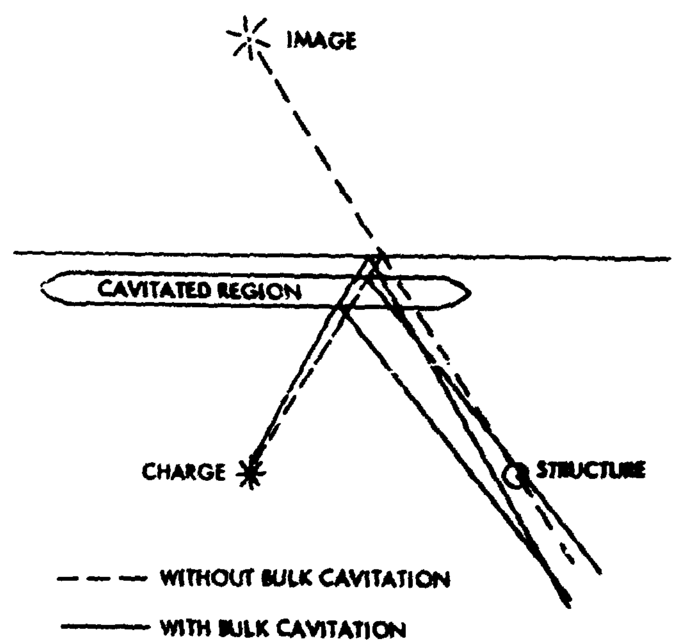

Figure 2-2 Free Field Ray Diagram

The DAA kinetic energy T_f and work potential Π_f for the fluid system may be written as

$$\begin{aligned} T_f &= \tfrac{1}{2}\, \underline{u}_S^T\, \underset{\sim}{M}_f\, \underline{u}_S \\ \Pi_f &= -\overset{*}{\underline{u}}{}_S^T\, \underset{\sim}{A}_f\, \underline{p}_S - \frac{1}{\rho c}\, \overset{*}{\underline{u}}{}_S^T\, \underset{\sim}{M}_f\, \dot{\underline{p}}_S \end{aligned} \tag{2.13}$$

where

$$\underset{\sim}{M}_f = \begin{bmatrix} \underset{\sim}{M} & \underset{\sim}{M}' \\ \underset{\sim}{M}' & \underset{\sim}{M} \end{bmatrix}, \quad \underset{\sim}{A}_f = \begin{bmatrix} \underset{\sim}{A} & \underset{\sim}{0} \\ \underset{\sim}{0} & \underset{\sim}{A} \end{bmatrix} \tag{2.14}$$

and an asterisk denotes temporal integration. The submatrix $\underset{\sim}{M}$ accounts for added mass coupling between wet-surface elements on S_+ and, similarly, between elements on S_-; M' accounts for added mass coupling between elements on S_+ and elements on S_-. The constraints for the fluid system are

$$\underset{\sim}{u}_S = \begin{bmatrix} \underset{\sim}{I} \\ -\underset{\sim}{I} \end{bmatrix} \underline{u}_{S+}, \quad \underline{p}_S = \begin{bmatrix} \underset{\sim}{I} \\ -\underset{\sim}{I} \end{bmatrix} \underline{p}_{S+} \tag{2.15}$$

so that (2.13) becomes

$$\begin{aligned} T_f &= \underline{u}_{S+}^T\, (\underset{\sim}{M} - \underset{\sim}{M}')\, \underline{u}_{S+} \\ \Pi_f &= -2\, \overset{*}{\underline{u}}{}_{S+}^T\, [\underset{\sim}{A}\, \underline{p}_{S+} + \frac{1}{\rho c}\, (\underset{\sim}{M} - \underset{\sim}{M}')\, \dot{\underline{p}}_{S+}] \end{aligned} \tag{2.16}$$

The application of Lagrange's equation [17] to (2.12) and (2.16) now yields

$$\begin{aligned} \underset{\sim}{M}_s\, \ddot{\underline{x}}_+ + \underset{\sim}{C}_s\, \dot{\underline{x}}_+ + K_s\, \underline{x}_+ &= \underline{f}_+ \\ \frac{1}{\rho c}\, (\underset{\sim}{M} - \underset{\sim}{M}')\, \dot{\underline{p}}_{S+} + \underset{\sim}{A}\, \underline{p}_{S+} &= (\underset{\sim}{M} - \underset{\sim}{M}')\, \dot{\underline{u}}_{S+} \end{aligned} \tag{2.17}$$

Also, (2.2) and (2.4) must be modified to include the effects of both the incident primary and image waves. This gives

$$\begin{aligned} \underline{f}_+ &= -\underset{\sim}{G}\, \underset{\sim}{A}\, (\overset{+}{\underline{p}}_{I+} + \overset{-}{\underline{p}}_{I+} + \underline{p}_{S+}) \\ \underset{\sim}{G}^T\, \dot{\underline{x}}_+ &= \overset{+}{\underline{u}}_{I+} + \overset{-}{\underline{u}}_{I+} + \underline{u}_{S+} \end{aligned} \tag{2.18}$$

where, e.g., $\overset{-}{\underline{p}}_{I+}$ denotes incident-wave pressure on S_+ associated with the image wave. The introduction of (2.18) into (2.17) then yields the doubly asymptotic interaction equations for problems involving a free surface

$$\underset{\sim}{M}_s \ddot{\underline{x}}_+ + \underset{\sim}{C}_s \dot{\underline{x}}_+ + \underset{\sim}{K}_s \underline{x}_+ = \underset{\sim}{G} \underset{\sim}{A} (\underline{p}^+_{I+} + \underline{p}^-_{I+} + \underline{p}_{S+})$$

$$(\underset{\sim}{M} - \underset{\sim}{M}') \dot{\underline{p}}_{S+} + \rho c \underset{\sim}{A} \underline{p}_{S+} = \rho c (\underset{\sim}{M} - \underset{\sim}{M}') (\underset{\sim}{G}^T \ddot{\underline{x}}_+ - \underline{u}^+_{I+} - \underline{u}^-_{I+}) \quad (2.19)$$

A comparison of (2.19) with (2.5) reveals that the effects of the free surface are embodied in the image-wave pressure and fluid-particle-velocity vectors, and in the modified added-mass matrix.

Finally, augmentation of (2.19) to secure unconditional stability, followed by introduction of the modified pressure [cf. (2.8)]

$$\underline{p}_M = \underset{\sim}{\Gamma}^+_+ \underline{p}^+_{I+} + \underset{\sim}{\Gamma}^-_+ \underline{p}^-_{I+} + \underline{p}_{S+} \quad (2.20)$$

to remove shock-wave singularities, proceeds as described in Subsections 2.3 and 2.4. The modified, augmented interaction equations corresponding to (2.9) for the infinite fluid medium are then readily obtained.

It is important to mention at this point that the DAA formulation just described does not account for high-frequency scattered waves from S_- that impinge upon S_+. For most floating structures, such waves are not generated, as the wet surfaces of S_+ and S_- usually intersect to form a convex surface; they are generated, however, for a totally submerged structure lying near the free surface. Even so, it has been shown that, as far as structural response is concerned, the effects of the scattered wave are generally negligible [18]. In other words, the response is basically driven by the incident primary and image waves.

2.6 BULK CAVITATION

In the absence of bulk cavitation, the imaging method serves as a useful device to model the reflection of free-field waves from the fluid's free surface. The occurrence of bulk cavitation near the surface, however, changes that simple acoustic reflection problem into a complex reflection-refraction problem, as indicated in Figure 2-2. If refraction distortions produced by a relatively thin cavitated region are not too severe, however, bulk cavitation effects will still appear to the structure as emanating from an image source.

Experimental records of free-field pressure histories for compact charges exhibit the behavior shown in Figure 2-3 [19]. The dashed line denotes the history produced by a negative-image model, while the horizontal line indicates that the effect of bulk cavitation is to "cut off" the pressure at a cavitation threshold. The approximate treatment introduced here involves pre-examination of the image-based free-field pressure at the

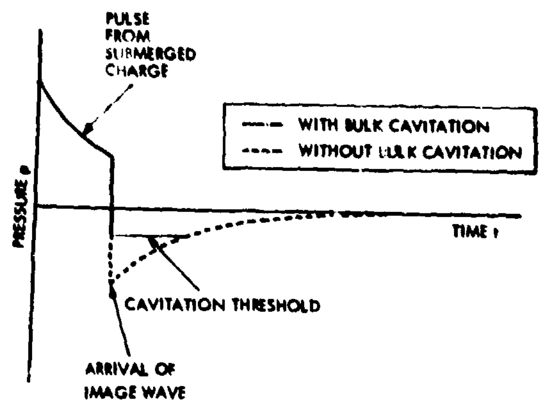

Figure 2-3 Free-Field Pressure as a Result of Free-Surface Reflection

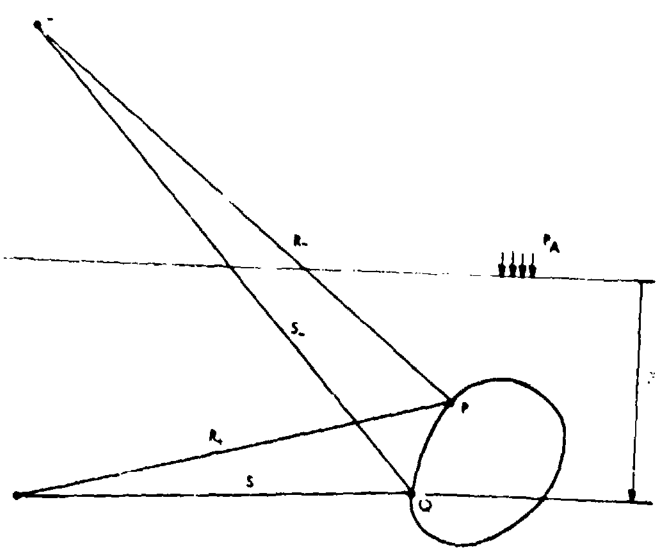

Figure 2-4 Geometry of Primary and Image Waves

standoff point, i.e., the point on the submerged structure closest to the charge. Whenever that pressure becomes negative to the extent that its magnitude exceeds the absolute ambient pressure at that depth, a positive contribution is incorporated into the negative-image source so that the free-field pressure at the standoff point never dips below the cavitation threshold. When the structure's overall dimensions are small relative to the distance from the structure to the cavitated region, the effects of the positive contribution will not vary appreciably in the vicinity of the structure.

The preceding discussion leads to the following development. The two-source model of Figure 2-4 yields as the free-field pressure at any point $\underline{P}$

$$p_{\underline{P}}(t) = \frac{S}{R_+} p_+ \left(t - \frac{R_+ - S}{c}\right) + \frac{S}{R_-} p_- \left(t - \frac{R_- - S}{c}\right) \tag{2.21}$$

where $p_+(t) = p_-(t) = 0$ for $t < 0$. At the standoff point, (2.21) becomes

$$p_Q(t) = p_+(t) + \frac{S}{S_-} p_- \left(t - \frac{S_- - S}{c}\right) \tag{2.22}$$

Now $p_-(t) = -p_+(t)$ as long as the resulting $p_Q(t)$ exceeds the cavitation threshold so that "cutoff" does not occur; otherwise, $p_Q(t)$ remains at the threshold value $-(p_A + \gamma Z)$ where p_A is atmospheric pressure and γ is the fluid's weight density. Hence, during the "cutoff period",

$$p_-(t) = -\frac{S_-}{S} \left[p_+ \left(t + \frac{S_- - S}{c}\right) + p_A + \gamma Z\right] \tag{2.23}$$

The model just described fits a prescribed free-field pressure history at the standoff point in such a way that surface cutoff effects appear to the structure as emanating from an image source. Because the model is complete, it also provides the free-field fluid-particle-velocity information required for DAA calculations. The usefulness of the model has been demonstrated from the results of free-field tests specifically designed to produce both pressure and fluid-particle-velocity data [20].

2.7 USA-DAA$_2$ IMPLEMENTATION

The Improved Doubly Asymptotic Approximation [DAA$_2$] can be written as [6]

$$\begin{aligned} &\underset{\sim}{M}_f \ddot{\underline{p}}_S + \rho c \underset{\sim}{A}_f \dot{\underline{p}}_S + \rho c \underset{\sim}{\Omega}_f \underset{\sim}{A}_f \underline{p}_S = \\ &\rho c \left[\underset{\sim}{M}_f(\underset{\sim}{G}^T \dddot{\underline{x}} - \ddot{\underline{u}}_I) \underset{\sim}{\Omega}_f M_f(G^T \ddot{\underline{x}} - \dot{\underline{u}}_I)\right] \end{aligned} \tag{2.24}$$

where

$$\underset{\sim}{\Omega}_f = \eta \rho c \underset{\sim}{A}_f \underset{\sim}{M}_F^{-1} \tag{2.25}$$

All vector and matrix quantities in the above are related to the same finite element wet-surface fluid mesh as that used for the lowest order DAA (DAA_1) described in Section 2.2.

Note that DAA_2 is a second-order equation, whereas DAA_1 is a first-order equation. In addition, DAA_2 includes a new scalar parameter η that appears in (2.25). It can be established from physical considerations [4] that η must be bounded as

$$0 \leq \eta \leq 1 \tag{2.26}$$

A precise choice of η is apparently not predicated by any fundamental principle. Hence it must be regarded at this time as a factor which may be adjusted to achieve optimum accuracy for a particular problem. In [6], it is observed that $\eta = 1$ leads to the best accuracy for a spherical shell.

In order to implement DAA_2 (2.24) is first integrated once in time and multiplied through by $\underset{\sim}{A}_f \underset{\sim}{M}_f^{-1}$. Equation (2.25) is then substituted into the result and a new variable, the scattered pressure integral $\underset{\sim}{q}_S$, is defined by

$$\underset{\sim}{q}_S = \overset{*}{\underset{\sim}{p}}_S \tag{2.27}$$

where an asterisk denotes temporal integration. The result is

$$\begin{aligned} &\underset{\sim}{A}_f \ddot{\underset{\sim}{q}}_S + \rho c \underset{\sim}{D}_{f1} \dot{\underset{\sim}{q}}_S + \eta \rho^2 c^2 \underset{\sim}{D}_{f2} \underset{\sim}{q}_S = \\ &\rho c \underset{\sim}{A}_f (\underset{\sim}{G}^T \ddot{\underline{x}} - \dot{\underline{u}}_I) + \eta \rho^2 c^2 \underset{\sim}{D}_{f1} (\underset{\sim}{G}^T \dot{\underline{x}} - \underline{u}_I) \end{aligned} \tag{2.28}$$

where

$$\underset{\sim}{D}_{f2} = \underset{\sim}{A}_f \underset{\sim}{M}_f^{-1} \underset{\sim}{A}_f \underset{\sim}{M}_f^{-1} \underset{\sim}{A}_f \tag{2.29}$$

It is noted that (2.28) is symmetric and that $\mathbf{D}_{f1}$ has already been defined following (2.6).

To avoid shock-wave singularities in $\dot{\mathbf{u}}_I$, the relation for a spherical shock is used as

$$\rho c \dot{\mathbf{u}}_I = \mathbf{\Gamma}(\dot{\mathbf{p}}_I + c\mathbf{R}^{-1}\mathbf{p}_I) \tag{2.30}$$

while the modified pressure-integral vector is defined as

$$\mathbf{q}_M = \mathbf{q}_S + \mathbf{\Gamma}\overset{*}{\mathbf{p}}_I \tag{2.31}$$

Substitution of (2.30, (2.31) into (2.28) then gives

$$\begin{aligned} \mathbf{A}_f \ddot{\mathbf{q}}_M + \rho c \mathbf{D}_{f1} \mathbf{q}_M + \eta\rho^2 c^2 \mathbf{D}_{f2} \mathbf{q}_M &= \\ \rho c \mathbf{A}_f \mathbf{G}^T \ddot{\mathbf{x}} + \eta\rho^2 c^2 \mathbf{D}_{f1}\mathbf{G}^T \dot{\mathbf{x}} &+ c\,[(1-\eta)\rho\mathbf{D}_{f1} - \mathbf{A}_f \mathbf{R}^{-1}]\mathbf{\Gamma}\mathbf{p}_I \\ &+ \eta\rho^2 c^2 (\mathbf{D}_{f2} - \tfrac{1}{\rho}\mathbf{D}_{f1}\mathbf{R}^{-1})\,\Gamma\,\overset{*}{\mathbf{p}}_I \end{aligned} \tag{2.32}$$

where the identity

$$\mathbf{R}^{-1}\mathbf{\Gamma} = \mathbf{\Gamma}\mathbf{R}^{-1} \tag{2.33}$$

has been used in (2.32), as both matrices are diagonal. Associated with (2.32) is the structural equation of motion

$$\mathbf{M}_s \ddot{\mathbf{x}} + \mathbf{C}_s \dot{\mathbf{x}} + \mathbf{K}_s \mathbf{x} = -\mathbf{G}\mathbf{A}_f [\dot{\mathbf{q}}_M + (\mathbf{I} - \mathbf{\Gamma})\mathbf{p}_I] \tag{2.34}$$

Equations (2.32) and (2.34) define the DAA_2-modified interaction equations that are solved according to the staggered solution strategy; hence an examination of stability must be conducted. It has been shown that the step-by-step integration of (2.32) and (2.34) is conditionally stable; however, no systematic study of stability has yet been undertaken. In view of the fact that unconditional stability was achieved for USA-DAA_1 by augmentation, and that (2.24) is essentially the DAA_1 with a correction term, augmentation of (2.32) was carried out in the same manner as that used for DAA_1.

Accordingly, (2.34) is first solved for $\ddot{\underset{\sim}{x}}$ and substituted into (2.32) to give

$$\begin{aligned}
&\underset{\sim}{A}_f \ddot{\underset{\sim}{q}}_M + \rho c (\underset{\sim}{D}_{f1} + \underset{\sim}{D}_s) \dot{\underset{\sim}{q}}_M + \eta \rho^2 c^2 \underset{\sim}{D}_{f2} \underset{\sim}{q}_m = \\
&\quad - \rho c \underset{\sim}{A}_f \underset{\sim}{G}^T \underset{\sim}{M}_s^{-1} (\underset{\sim}{C}_s \dot{\underset{\sim}{x}} + \underset{\sim}{K}_s \underset{\sim}{x}) + \eta \rho^2 c^2 \underset{\sim}{D}_{f1} \underset{\sim}{G}^T \dot{\underset{\sim}{x}} \\
&\quad - \rho c \{\underset{\sim}{D}_s - [\underset{\sim}{D}_s + (1-\eta) \underset{\sim}{D}_{f1} - \frac{1}{\rho} \underset{\sim}{A}_f \underset{\sim}{R}^{-1}] \underset{\sim}{\Gamma}\} \underset{\sim}{p}_I \\
&\quad + \eta \rho^2 c^2 (\underset{\sim}{D}_{f2} - \frac{1}{\rho} \underset{\sim}{D}_{f1} \underset{\sim}{R}^{-1}) \underset{\sim}{\Gamma} \overset{*}{\underset{\sim}{p}}_I
\end{aligned} \qquad (2.35)$$

where $\underset{\sim}{D}_s$ has already been defined following (2.6).

Equations (2.34) and (2.35) are the DAA_2-modified, augmented interaction equations that have been implemented in the USA Code.

SECTION III

ORGANIZATION OF USA-STAGS CODE

Organization of the USA-STAGS system is shown in Figure 3-1. STAGS operates on two levels within this structure; first as a preprocessor, and second as a driven utility during the time integration phase of the analysis. In the preprocessing mode STAGS generates two types of information. The first is data that are required later by the STAGS time integrator, and the second is data that are needed for fluid preprocessing. Both sets of information are placed in mass storage where the latter data are retrieved by the fluid mass matrix processor FLUMAS and then by the processor AUGMAT. AUGMAT produces the final form of the fluid matrix equations to be integrated. Data transfer within USA is carried out with the data manager DMGASP, while out-of-core processing in FLUMAS is accomplished by the virtual memory simulator VMSYST. Out-of-core processing of the fluid equation system during time integration is carried out by the SKYPUL processor which is not shown in 3-1.

The time integration processor is TIMINT which drives both the USA integrator for the fluid and the STAGS integrator for the structure. TIMINT places the structural displacements and velocities and the total fluid pressures into mass storage at each time step. User selected response data are then displayed in tabular and graphic form at the conclusion of the run. The processor POSTPR has the same display capability as TIMINT, but is used for more detailed examination of the results at a later time.

In the following these separate functional components are discussed individually. Detailed information for utilization of the code is contained in the Appendices.

3.1 STAGS PREPROCESSING

Execution of a purely structural analysis, linear or nonlinear, is carried out by two independent programs STAGS1 and STAGS2. The STAGS1 program is basically a preprocessor which reads input data defining a structural model with loads and boundary conditions and prepares an output file, TAPE2, for use by STAGS2. STAGS2 performs the actual analysis and reads no input. The STAGS1 preprocessor program has been slightly modified for use with the USA Code. Input data for STAGS1, as described in the STAGS Users Manual [3], remains unchanged except for one logical record, B-1. An additional data word, IFLUA, is added to this record. A value of -1 for this item signifies the USA-STAGS combination will be executed. The user must also ensure that the local coordinate systems associated with each wet surface of the structure must be consistent

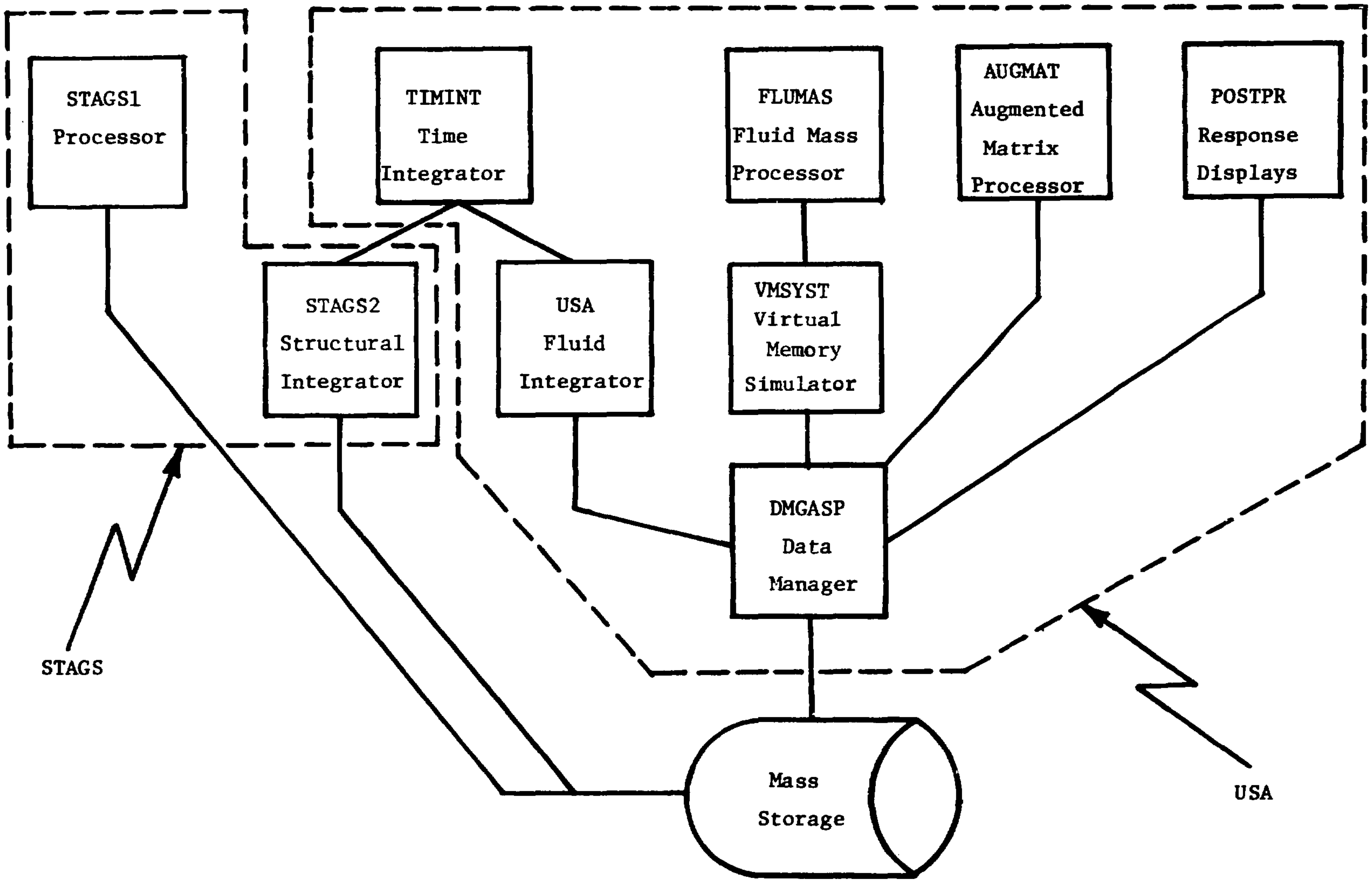

Figure 3-1 Organization of the USA-STAGS Code

with normal displacements that are positive into the fluid. The STAGS1 processor then outputs two additional files, TAPE18 and TAPE19. TAPE18 contains a list of global coordinates of the structural nodes. TAPE19 contains diagonal mass components for each structural degree of freedom and also a vector which identifies the degree of freedom numbers with displacement components at the nodes. Both files are sequential and may be saved on tapes (by system copy utility routines) or as permanent disc files; however, for immediate access by USA processors, disc files are preferable. These data are retrieved by the fluid processors FLUMAS and AUGMAT whose functions are described below. The STAGS1 preprocessor also prepares a sequential "model definition file" on TAPE21. This file may be used as input with the STAGS plot program (STAPL) to obtain plots of the structural model.

3.2 THE FLUID MASS PREPROCESSOR FLUMAS

This code constructs the fluid mass matrix for a structure submerged in an infinite, inviscid, incompressible fluid by the boundary element technique [16]. In addition, FLUMAS can form the mass matrix for a body in the vicinity of a fluid free surface through the use of imaging techniques. Out-of-core processing is facilitated by use of the virtual memory system VMSYST so that core size is not a limitation on the number of fluid DOF. The code also generates fluid mesh data and a set of transformation coefficients relating the structural and fluid DOF. The computation of these coefficients is based upon the use of centroidal nodes for the fluid elements and the assumption of a bilinear variation of displacement over the surface of each structural element. This assures that the description of the fluid pressure forces in the two mesh systems is statically equivalent without inducing moments at the structural nodes. Finally, the code generates the symmetric matrices D_{f1} and D_{f2} that appear in the computational form of the DAA_1 and DAA_2 equations which involve the inverse of the fluid mass matrix.

FLUMAS contains a refined formulation for the fluid mass matrix that includes the primary effects of element curvature. In addition, it has the capability to treat structures containing both general geometry and arbitrary axis, multi-branch, multi-harmonic surface-of-revolution components, as described in [10]. The code can also efficiently construct the fluid mass matrix for a body with one or two planes of symmetry by using a mesh which covers 1/2 or 1/4 of the surface. Symmetric or anti-symmetric fluid motions can then be imposed on the portions of the surface not covered by the mesh. Two-dimensional "plane-strain" behavior of long cylinders can also be simulated. The code contains an automatic mesh generator for cylindrical surfaces and an improved error exit control that facilitates fluid mesh debugging. Finally, a useful diagnostic tool in the code is the capability to solve the fluid-boundary-mode problem $\underset{\sim}{M}_f\,\underline{u} = \lambda \underset{\sim}{A}_f \underline{u}$ [16].

Typical input data for this processor includes

- o Mesh geometry
  - Fluid wet-surface mesh
  - Structure wet-surface mesh
- o Element definitions
  - General curved surface
  - Surface of revolution
- o Material property
  - Mass density
  - Speed of sound
  - DAA_2 parameter
- o Constraints
  - Location of free surface
  - Half model
  - Quarter model
  - Long cylinder
  - Node reassignment in fluid-structure transformation

A detailed description of the required input data is given in Appendix C.

3.3 THE AUGMENTED MATRIX PREPROCESSOR AUGMAT

This processor uses data from both STAGS1 and FLUMAS to construct the specific matrices required for solution of the augmented Eqs. (2.9) or (2.34)/(2.35). The output of this code includes not only the required matrices in skyline form, but also a condensation of the output from both STAGS1 and FLUMAS. This has been done so that only one permanent file need by referenced as input to the time integrator; this results in improved data handling and core usage. In contrast to earlier versions of USA-STAGS, AUGMAT does not form the fluid matrices D_{f1} and D_{f2} but rather puts them in the skyline format required by SKYPUL [21,22]. D_{f1} and D_{f2} are now formed only in FLUMAS. Input to this code involves the following information

- Mass matrices
  - Fluid
  - Structure
- Structural DOF correspondence table
  - External and internal node descriptions
  - Factorization order
  - DOF reduction due to constraints
- Fluid mesh geometry
  - Global coordinates of fluid nodes
  - Direction cosines for nodal surface normals
  - Areas of fluid element
- Fluid/structure DOF transformation coefficients
- Fluid material properties
  - DAA_2 parameter
- Constraints
  - Half model
  - Quarter model

Although this constitutes a substantial amount of information, almost all of it is retrieved from permanent data files. A detailed discussion of the required input data is contained in Appendix D.

3.4 THE TIME INTEGRATION PROCESSOR TIMINT

This main processor constitutes an implementation of the unconditionally stable staggered solution technique developed in [4] for DAA_1. The primary output is a set of permanent data files that contain nodal values for structural displacement, structural velocity and wet-surface pressure at every time step. In addition, parallel files are created that retain restart information at time intervals dictated by the user. The code has a variable time step capability and can treat a spherical incident wave of arbitrary pressure profile and source location. Exponentially decaying waves can also be treated by providing magnitude and decay information. In addition, incident wave pressure and particle velocity are tabulated and displayed with a "printer-plot" package. If the body is in the vicinity of a free surface, unloading due to reflection of the incident wave from the surface is included and the effects of bulk cavitation on the free field pressure history are approximately treated. Finally, selected response

histories can be listed and then displayed for immediate examination using the "printer-plot" graphics package embedded both in TIMINT and in POSTPR (see Sec. 3.5).

The computational strategy for the staggered solution procedure is embodied in the following eight steps, assuming the solution is known at time t:

(1) Estimate the unknown structural restoring force vector at $t + \Delta t$ from the extrapolation of current and past values

(2) Transform this extrapolation into fluid node values and form the right-hand side of the fluid equation, which also involves the known incident pressure at $t + \Delta t$

(3) Solve the fluid equation and obtain a preliminary estimate of the total pressure vector at $t + \Delta t$

(4) Transform fluid pressures into structural nodal forces

(5) Solve the structural equation for the displacement and velocity vectors at $t + \Delta t$

(6) Transform the computed structural restoring forces at $t + \Delta t$ into fluid node values and reform the right hand side of the fluid equation

(7) Re-solve the fluid equation and obtain refined values for the total pressures at $t + \Delta t$

(8) Save system responses

Steps 1, 3, and 5 constitute the basic staggered solution technique, while Steps 2 and 4 are required because of the difference between the fluid and structural surface meshes. The iteration on the fluid solution reflected in Steps 6 and 7 has been added to enhance accuracy. Inasmuch as the computation time is overwhelmed by the structural solution, this requires only a small increase in total run time. The use of a three-point extrapolation method in Step 1 also improves accuracy, as discussed in [4]. The 3-step implicit Park [23] integration method is used for the fluid solution, while the integration algorithms embedded in STAGS have been described earlier.

Typical input to this processor includes

o Incident wave characteristics

    Location of source

    Location of standoff

    Pressure profile

    Linear interpolation

    Cubic spline fit

    Exponentially decaying wave

- Time step information
    - Start and finish times
    - Time increment values
- Restart data
- Display directives
    - Displacements
    - Velocities
    - Pressures

Detailed user information concerening TIMINT is given in Appendix E.

3.5 THE RESPONSE POSTPROCESSOR POSTPR

This utility is responsible for the listing and "printer-plot" as well as "vector-plot" graphic display of selected system responses and pseudo-velocity shock spectra. Output files containing the structural displacement field at user-specified instants in time may also be created from the response history files to provide "snapshots" of the deformed structure. Some of the same capabilities are also embedded in the TIMINT processor for immediate selective scanning of the output. POSTPR, however, is used for more detailed examination of the results at a later time. As a complete display of all structural and fluid DOF histories for even a moderate size problem could run into thousands of pages of output, care must be exercised in the selection of data to be displayed. Usage of this code is discussed in Appendix F.

3.6 THE DATA MANAGER DMGASP

DMGASP is a self-contained utility module that functions as a manager of auxiliary storage and as the focal point for all block input/output activities [24]. Constituting the lowest level of the NOSTRA Data Management System [25], it carries out the direct transfer of data blocks between core and peripheral storage. (The terminology "direct transfer" is used here to denote unformatted and unbuffered data transmission.) The basic auxiliary storage management operations embodied in DMGASP are

- Activate storage device
- Position device
- Read data block from device
- Write data block on device
- Deactivate device

In the USA Code, DMGASP is operated as a stand-along I/O package that receives directives directly from the master processors. Assembly language versions of DMGASP currently exist for UNIVAC 1100 EXEC-8, CDC SCOPE 3.4 (NOS/BE), and CDC NOS operating systems.

The UNIVAC version of DMGASP has been operational since 1974 and embodies a wide spectrum of extensively tested functions, including magnetic tape handling. On the other hand, the CDC SCOPE version has been operational since mid-1977 and has been tested only on a subset of functions dealing with mass storage I/O. The CDC NOS is a variant of the CDC SCOPE version and has been used since late 1977.

Finally, a FORTRAN 77 version of DMGASP was produced in 1980 for the VAX 11/780.

3.7 THE VIRTUAL MEMORY SIMULATOR VMSYST

VMSYST is a virtual storage simulator for computers that are not built around a virtual memory system [26]. All data in the virtual system is partitioned into pages, which are blocks of consecutive data words of a fixed page size. Pages residing in core in the page buffer are called active pages. Inactive pages are resident in auxiliary storage only. In this utility the page and page buffer sizes can be conveniently adjusted to suit the application. Input and output to auxiliary storage is handled by DMGASP; otherwise VMSYST is written in transportable FORTRAN.

The primary advantage of a virtual memory system is the efficient processing of many small records such as columns or rows of large full matrices that can be treated as vectors. In essence VMSYST keep track of whether a desired block of data is resident in core in the page buffer, or, has been moved to an external storage device by DMGASP. If it is not currently resident in the page buffer, VMSYST retrieves it and makes it available to the application progrm. This double movement of data is the major price paid for the benefits of the virtual system.

In USA-STAGS, VMSYST is used for the out-of-core generation of the fluid mass matrix described in Section 3.2.

3.8 THE SKYPUL PROCESSOR

SKYPUL (SKYmatrix Processing Utility Library) is a system of computer codes designed to process large-order sparse symmetric matrices stored in the so-called skyline, profile, envelope or variable-band arrangement [22]. Although the fluid equation system produced by the family of doubly asymptotic approximations is full, SKYPUL can process this system in a multi-block out-of-core mode so that there is no essential restriction on the number of fluid degrees of freedom that can be used.

The main virtues of SKYPUL are the generality of the representation and the simplicity of storage resource management. The latter advantage is reflected in the clean implementation of the basic skymatrix processing operations such as factorization and equation solving. The resulting codes are relatively easier to understand and maintain than those based on more sophisticated sparse matrix storage schemes.

A distinguishing feature of SKYPUL is that all of the constituent programs comply with the organizational, internal documentation, and array self-description standards set forth in the General Description Manual of the Engineering Analysis System (EASY) [21].

SECTION IV

EXAMPLE PROBLEMS

This section is eventually intended to contain a collection of sample problems for USA-STAGS that covers the general range of application to linear and non-linear analysis of structures with simple geometric shapes, i.e., cylinders and spheres. At this time only one sample problem is included, that of the infinite circular cylindrical shell excited by a transverse, plane, step wave. The case considered here is for linear elastic behavior only and, although this does not fully demonstrate the computational power of USA-STAGS, it does lend itself to direct comparison of the same problem treated by USA in its stand alone configuration [2].

4.1 SUBMERGED INFINITE CYLINDRICAL SHELL

For this problem, a 72-node, 36-element model with a uniform circumferential mesh was constructed. The length of the cylindrical shell equalled the circumferential dimension of the square plate elements used for the model; hence the shell was one element long. Kinematic constraints of zero axial displacement and no end rotation were enforced through appropriate input to STAGS1. The fluid model consists of 36 equally-spaced elements around the circumference; the two-dimensional nature of the infinite shell geometry was simulated by exercising an option in the fluid preprocessor FLUMAS that adds fictitious elements in the axial direction.

The transverse, plane step-wave is of unit incident pressure and material properties are used that correspond to a steel shell immersed in water. The input data are normalized so that the density and speed of sound for the fluid both equal unity; hence, the density, Young's modulus, and Poisson's ratio for the structural material are taken as 7.85, 98.125, and 0.3, respectively. The radius and wall thickness of the cylinder are 1 and 0.01, respectively.

Computational results are shown in detail in Appendices B through F and it is noted that there is little discernable difference between the USA-STAGS and USA-SPAR analyses (See [2]).

REFERENCES

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APPENDIX A

CONTROL CARDS FOR CDC FILE MANIPULATION AND PROGRAM EXECUTION

CDC 6000 NOS 1.1 CONTROL CARDS

FILE DESCRIPTION

NAME	FUNCTION	(PROGRAM)
FLUMAS	FLUID MASS PROCESSOR	(FLUMAS)
AUGMAT	AUGMENTED MATRIX PROCESSOR	(AUGMAT)
POSTPR	RESPONSE DISPLAY PROGRAM	(POSTPR)
STAGS1	STAGS PREPROCESSOR	(STAGS1)
STAGS2	STAGS EXECUTION PROGRAM	(STAGS2)
STAPL	STAGS PLOT PROCESSOR	(STAPL)
USAS	USA-STAGS PROGRAM	(USAS)
FLUSYM	FLUID MASS SOURCE	(FLUMAS)
AUGSYM	AUGMENTED MATRIX SOURCE	(AUGMAT)
POSSYM	RESPONSE DISPLAY SOURCE	(POSTPR)
IOMSYM	DATA MANAGER SOURCE	(FLUMAS/AUGMAT/USAS/POSTPR)
IOMLIB	DATA MANAGER LIBRARY	(FLUMAS/AUGMAT/USAS/POSTPR)
VIRSYM	VIRTUAL MEMORY SOURCE	(FLUMAS)
VIRLIB	VIRTUAL MEMORY LIBRARY	(FLUMAS)
INTSYM	FLUID INTEGRATION SOURCE	(USAS)
INTLIB	FLUID INTEGRATION LIBRARY	(USAS)
SKUSYM	SKYLINE PROCESSOR SOURCE	(USAS)
SKULIB	SKYLINE PROCESSOR LIBRARY	(USAS)
MODSYM	INTSYM MODIFICATION SOURCE	(USAS)
MODLIB	INTLIB MODIFICATION LIBRARY	(USAS)
USASYM	USAS OVERLAY SOURCE	(USAS)
USAREL	USAS OVERLAY RELOCATABLE	(USAS)
SOV1	STAGS1 OVERLAY SOURCE	(STAGS1)
ROV1	STAGS1 OVERLAY RELOCATABLE	(STAGS1)
SOV2	STAGS2 OVERLAY SOURCE	(STAGS2)
ROV2	STAGS2 OVERLAY RELOCATABLE	(STAGS2)
SYM1	STAGS1 SOURCE	(STAGS1)
LIB1	STAGS1 LIBRARY	(STAGS1)
SYM2	STAGS2 SOURCE	(USAS/STAGS2)
LIB2	STAGS2 LIBRARY	(USAS/STAGS2)
SYMU	STAGS UTILITY SOURCE	(STAGS1/STAGS2/STAPL/USAS)
LIBU	STAGS UTILITY LIBRARY	(STAGS1/STAGS2/STAPL/USAS)
STAPL	STAPL SOURCE	(STAPL)
RELPL	STAPL RELOCATABLE	(STAPL)
USTSYM	USA-STAGS INTERFACE SOURCE	(USAS)
USTLIB	USA-STAGS INTERFACE LIBRARY	(USAS)

* *

RELOCATABLE/LIBRARY FILE GENERATION

CONTROL CARD

```
UPDATE(P=IOMSYM,I=ZZ,F)
FTN(L=0,I=COMPILE,B=IOMREL,S=OPOTEXT/PFNTEXT)
LIBGEN(F=IOMREL,P=IOMLIB)
```

```
UPDATE(P=FLUSYM,I=ZZ,F)
FTN(L=0,I=COMPILE,B=FLUMAS)

UPDATE(P=VIRSYM,I=ZZ,F)
FTN(L=0,I=COMPILE,B=VIRREL)
LIBGEN(F=VIRREL,P=VIRLIB)

UPDATE(P=AUGSYM,I=ZZ,F)
FTN(L=0,I=COMPILE,B=AUGMAT)

UPDATE(P=INTSYM,I=ZZ,F)
FTN(I=COMPILE,L=0,B=INTREL)
LIBGEN(F=INTREL,P=INTLIB)

UPDATE(P=SKLSYM,I=ZZ,F)
FTN(I=COMPILE,L=0,B=SKUREL)
LIBGEN(F=SKUREL,P=SKULIB)

UPDATE(P=MODSYM,I=ZZ,F)
FTN(I=COMPILE,L=0,B=MODREL)
LIBGEN(F=MODREL,P=MODLIB)

UPDATE(P=POSSYM,I=ZZ,F)
FTN(L=0,I=COMPILE,B=POSTPR)

UPDATE(P=USASYM,I=ZZ,F)
FTN(L=0,I=COMPILE,B=USAREL,PL=400000)

UPDATE(P=SOV1,I=ZZ,F)
FTN(L=0,I=COMPILE,B=RCV1,PL=100000)

UPDATE(P=SOV2,I=ZZ,F)
FTN(L=0,I=COMPILE,B=RCV2,PL=400000)

UPDATE(P=SYM1,I=ZZ,F)    NO INPUT RECORD FOR UPDATE
FTN(L=0,I=COMPILE,OPT=2,B=REL1)
LIBGEN(F=REL1,P=LIB1)

UPDATE(P=SYM2,I=ZZ,F)
FTN(L=0,I=COMPILE,OPT=2,B=REL2)
LIBGEN(F=REL2,P=LIB2)

UPDATE(P=SYMU,I=ZZ,F)
FTN(L=0,I=COMPILE,OPT=2,B=RELU,S=CPCTEXT)
LIBGEN(F=RELU,P=LIBU)

UPDATE(P=USTSYM,I=ZZ,F)
FTN(I=COMPILE,L=0,B=USTREL)
LIBGEN(F=USTREL,P=USTLIB)

        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                      ABSOLUTE PROGRAM GENERATION

* * * * * * *
CONTROL CARD
* * * * * * *
```

```
DEFINE,STAGS1.
LDSET(PRESET=ZERO,LIB=LIB1/LIBU)
LOAD(ROV1)
NOGO(STAGS1)

DEFINE,USAS.
LDSET(PRESET=ZERO,LIB=USTLIB/LIB2/LIBU/MODLIB/INTLIB/ICMLIB/SKULIB)
LOAD(USAREL)
NOGO(USAS)

DEFINE,STAGS2.
LDSET(PRESET=ZERO,LIB=LIB2/LIBU)
LOAD(ROV2)
NOGO(STAGS2)

     * * * * * * * * * * * * * * * * * * * * * * *

                         STAGS1 EXECUTION
                         (PREPARATORY TO FLUID MASS AND
                          AUGMENTED MATRIX PREPROCESSING)

* * * * * * *
CONTROL CARD
* * * * * * *

ATTACH,STAGS1.
DEFINE(TAPE18=GLOCOR,ID=USER)
DEFINE(TAPE19=STRMAS,ID=USER)
DEFINE,TAPE21=MOD1.      (OPTIONAL)  DATA FOR STAPL PLOT OF MODEL
STAGS1.         READ STAGS1 INPUT.

     * * * * * * * * * * * * * * * * * * * * * * *

                         FLUMAS EXECUTION

LIBRARY(IOMLIB,VIRLIB)
FLUMAS.         READ FLUMAS INPUT WITH GRDMAP = USER*GLOCOR

     * * * * * * * * * * * * * * * * * * * * * * *

                         AUGMAT EXECUTION

LIBRARY(IOMLIB)
AUGMAT.         READ AUGMAT INPUT WITH STRMAP = USER*STRMAS

     * * * * * * * * * * * * * * * * * * * * * * *

                         STAGS1-USAS EXECUTION  (INITIAL RUN)

ATTACH,STAGS1,USAS.
DEFINE,TAPE22=RUN1.           SAVE DATA FOR RESTART OR STAPL PLOTS.
RFL(120000)
REDUCE(-)
STAGS1.         READ STAGS1 INPUT.
RFL(200000)
REDUCE(-)
USAS.           READ USAS INPUT
```

```
* * * * * * * * * * * * * * * * * * * * * * *

                    STAGS1-USAS EXECUTION  (RESTART)

* * * * * * *
CONTROL CARD
* * * * * * *

RFL(120000)
REDUCE(-)
STAGS1,,X.     READ STAGS1 INPUT,  SUPPRESS STAGS1 OUTPUT.
ATTACH,RUN1.
DEFINE,TAPE22=RUN2.
COPYBF,RUN1,TAPE22.
RFL(200000)
REDUCE(-)
USAS.          READ USAS INPUT.

* * * * * * * * * * * * * * * * * * * * * * *

                    POSTPR EXECUTION

LIBRARY(IOMLIB,INTLIB)
POSTPR.        READ POSTPR INPUT.

* * * * * * * * * * * * * * * * * * * * * * *

                    STAGS1-STAGS2 EXECUTION

ATTACH,STAGS1,STAGS2.
RFL(120000)    STAGS1 FIELD LENGTH SHOULD BE LESS THAN STAGS2 FIELD LENGTH
REDUCE(-)
STAGS1.        READ STAGS1 INPUT.
RFL(160000)
REDUCE(-)
STAGS2.        COMPLETE PROBLEM SOLUTION.

* * * * * * * * * * * * * * * * * * * * * * *
```

APPENDIX B
SAMPLE PROBLEM FOR STAGS1 PREPROCESSING

This appendix contains a sample input deck and subsequent output for the infinite cylindrical shell problem presented in Section 4. See STAGS user manual [3] for detailed instructions for deck setup.

```
                 STAGS-C1   JUN80   VAX 11/780

+++  OPEN,   10 = FOR010                  , Acc= DIRECT , Stat= SCRATCH


                           INPUT DATA CARDS.  PAGE     1
CARD NUMBER      ****************************** DATA ************************************

     1           STAGS1 DATA FOR FULL CYLINDER
     2           6 0 0 0 1 -1 $ B-1
     3           1 0 0 1 $ B-2
     4           1 0 1 $ B-3
     5           1.
     6           0.
     7           0 1000 0 2 $ D-1
     8           0. 1000. .05 .1
     9           0 1
    10           2 37 $ F-1
    11           1 4 1 2 $ G-1 CLOSED SHELL CONDITION
    12           1 0 $ I-1
    13           98.125 .3 0. 7.85 $ I-2
    14           1 1 1 $ K-1
    15           1 .01
    16           5 4
    17           0. .1750 0. 360. 1.
    18           0. 0. 0.
    19           0. 90. 0.
    20           1 0 0. 0. 1 $ M-5
    21           410
    22           4 6 4 3 $ P-1 BOUNDARY CONDITIONS
    23           0
    24           0
```

```
                         STAGS-C1 / PHASE 1

CASE TITLE  -  STAGS1 DATA FOR FULL CYLINDER


COMPUTATIONAL STRATEGY


                  GRAV=    0.100000E+01
- - - TRANSIENT RESPONSE ANALYSIS - - -

                  COMBINED STRUCTURAL-FLUID ANALYSIS

              STARTING LOAD FACTOR    STEP LOAD         MAXIMUM LOAD
LOAD FACTOR A    0.0000000E+00       0.0000000E+00      0.0000000E+00

IXSTF            IXFAC
   0                0

 ISTART   ISEC   ICUT  INEWT  ISTRAT
    0   1000      0      2      0

ERROR TOLERANCE =    0.100000E-02 UNDERRELAXATION =    0.000000E+00

 TIME INCREMENT ------------- 5.00000E-02

 START AND STOP TIMES ------- 0.00000E+00 1.00000E+03

 MAX. EXPECTED DISPLACEMENT - 1.00000E-01

 ALPHA                        0.00000E+00

 BETA               --------- 0.00000E+00

 STARTING TIME FOR AUTOMATIC TIME STEP INCREASE     0.000000E+00

IMPLICIT ORDINARY DIFFERENTIAL EQUATION SOLVER
TRAPEZOIDAL FORMULA
```

```
MODEL COMPOSITION
-----------------
-----------------

    ITEM                 QUANTITY
    --------------       --------
    SHELL   UNITS            1
    ELEMENT UNITS            0
    ----------------------------
    TOTAL   UNITS            1
    -------------------------


SHELL UNIT SUMMARY
------------------
------------------

    UNIT       ROWS    COLS
    ----       ----    ----
       1          2      37

NUMBER OF INTERSECTIONS INVOLVING SHELL UNIT BOUNDARIES (NINTS) =     1

NINTS =  1   MUNIT =  1   MBOUND =  4   NUNIT =  1   NBOUND =  2


BLANK COMMON BUFFER DIMENSION (NSPACE)
--------------------------------------
    DECIMAL         HEX
      16000        3E80


VIRTUAL MEMORY SPECIFICATIONS
NO. OF PAGES      PAGE SIZE
           7           1279

FM DATA SPACE =    5696.   BLOCK SIZE =    5003
```

RESOURCE DATA TABLES

TABLE	NO. OF ENTRIES
MATERIAL	1
BEAM SECTION	0
WALL CONSTRUCTION	1
USER PARAMETERS	^

MATERIAL PROPERTY TABLE

ITAM	E1	U12	G	RHO	A1	E2	A2
1	0.98125E+02	0.30000E+00	0.37740E+02	0.78500E+01	0.00000E+00	0.98125E+02	0.00000E+00

NO. OF TABULATED MATERIALS (NTAM) = 1

SHELL WALL PROPERTY TABLE

ITAW = 1, GENERAL LAYERED SHELL, NLAY = 1, NLIP = 0

ILAY	MATL	TL	ZETL	LSO
1	1	0.10000E-01	0.00000E+00	0

NO. OF TABULATED WALLS (NTAW) = 1

```
UNIT  1 (SHELL)  -  DESCRIPTION
-------------------------------
-------------------------------


SURFACE GEOMETRY
----------------

 CYLINDER.

   X1 =   0.0000E+00              PROP(5) =   0.1000E+01
   X2 =   0.1750E+00              PROP(6) =   0.0000E+00
   Y1 =   0.0000E+00              PROP(7) =   0.0000E+00
   Y2 =   0.3600E+03              PROP(8) =   0.0000E+00


GLOBAL ORIENTATION
------------------

IGLOBE = 4   -   GLOBAL ORIENTATION VIA TRANSLATION OF UNIT ORIGIN PLUS EULERIAN ANGLES

XG =      0.0000E+00,    YG =      0.0000E+00,     ZG =      0.0000E+00


ROTATION OF UNIT ABOUT
     X-AXIS          Y-AXIS          Z-AXIS
 0.0000000E+00  0.9000000E+02  0.0000000E+00


WALL CONSTRUCTION
-----------------
    TABULATED ENTRY          ECCENTRICITY    ORIENTATION
             1                 0.0000E+00     0.0000E+00 DEG.


DISCRETIZATION
--------------

    GRIDPOINTS
    ----------
    ROWS    COLS
      2      37


    X-SPACING
      UNIFORM
```

Y-SPACING
UNIFORM

SHELL ELEMENTS

QUAF - 410

BOUNDARY LINE	MESH ROW	MESH COL	COORDINATES SURFACE X	COORDINATES SURFACE Y	COORDINATES GLOBAL CARTESIAN XG	YG	ZG
1	1	1	0.0000	0.0000	1.0000	0.0000	0.0000
1	1	2	0.0000	10.0000	0.9848	0.1736	0.0000
1	1	3	0.0000	20.0000	0.9397	0.3420	0.0000
1	1	4	0.0000	30.0000	0.8660	0.5000	0.0000
1	1	5	0.0000	40.0000	0.7660	0.6428	0.0000
1	1	6	0.0000	50.0000	0.6428	0.7660	0.0000
1	1	7	0.0000	60.0000	0.5000	0.8660	0.0000
1	1	8	0.0000	70.0000	0.3420	0.9397	0.0000
1	1	9	0.0000	80.0000	0.1736	0.9848	0.0000
1	1	10	0.0000	90.0000	0.0000	1.0000	0.0000
1	1	11	0.0000	100.0000	-0.1736	0.9848	0.0000
1	1	12	0.0000	110.0000	-0.3420	0.9397	0.0000
1	1	13	0.0000	120.0000	-0.5000	0.8660	0.0000
1	1	14	0.0000	130.0000	-0.6428	0.7660	0.0000
1	1	15	0.0000	140.0000	-0.7660	0.6428	0.0000
1	1	16	0.0000	150.0000	-0.8660	0.5000	0.0000
1	1	17	0.0000	160.0000	-0.9397	0.3420	0.0000
1	1	18	0.0000	170.0000	-0.9848	0.1736	0.0000
1	1	19	0.0000	180.0000	-1.0000	0.0000	0.0000
1	1	20	0.0000	190.0000	-0.9848	-0.1736	0.0000
1	1	21	0.0000	200.0000	-0.9397	-0.3420	0.0000
1	1	22	0.0000	210.0000	-0.8660	-0.5000	0.0000
1	1	23	0.0000	220.0000	-0.7660	-0.6428	0.0000
1	1	24	0.0000	230.0000	-0.6428	-0.7660	0.0000
1	1	25	0.0000	240.0000	-0.5000	-0.8660	0.0000
1	1	26	0.0000	250.0000	-0.3420	-0.9397	0.0000
1	1	27	0.0000	260.0000	-0.1736	-0.9848	0.0000
1	1	28	0.0000	270.0000	0.0000	-1.0000	0.0000
1	1	29	0.0000	280.0000	0.1736	-0.9848	0.0000
1	1	30	0.0000	290.0000	0.3420	-0.9397	0.0000
1	1	31	0.0000	300.0000	0.5000	-0.8660	0.0000
1	1	32	0.0000	310.0000	0.6428	-0.7660	0.0000
1	1	33	0.0000	320.0000	0.7660	-0.6428	0.0000
1	1	34	0.0000	330.0000	0.8660	-0.5000	0.0000
1	1	35	0.0000	340.0000	0.9397	-0.3420	0.0000
1	1	36	0.0000	350.0000	0.9848	-0.1736	0.0000

1	1	37	0.0000	360.0000	1.0000	0.0000	0.0000

BOUNDARY	MESH		SURFACE		GLOBAL CARTESIAN		
LINE	ROW	COL	X	Y	XG	YG	ZG
2	1	37	0.0000	360.0000	1.0000	0.0000	0.0000
2	2	37	0.1750	360.0000	1.0000	0.0000	-0.1750

BOUNDARY	MESH		SURFACE		GLOBAL CARTESIAN		
LINE	ROW	COL	X	Y	XG	YG	ZG
3	2	1	0.1750	0.0000	1.0000	0.0000	-0.1750
3	2	2	0.1750	10.0000	0.9848	0.1736	-0.1750
3	2	3	0.1750	20.0000	0.9397	0.3420	-0.1750
3	2	4	0.1750	30.0000	0.8660	0.5000	-0.1750
3	2	5	0.1750	40.0000	0.7660	0.6428	-0.1750
3	2	6	0.1750	50.0000	0.6428	0.7660	-0.1750
3	2	7	0.1750	60.0000	0.5000	0.8660	-0.1750
3	2	8	0.1750	70.0000	0.3420	0.9397	-0.1750
3	2	9	0.1750	80.0000	0.1736	0.9848	-0.1750
3	2	10	0.1750	90.0000	0.0000	1.0000	-0.1750
3	2	11	0.1750	100.0000	-0.1736	0.9848	-0.1750
3	2	12	0.1750	110.0000	-0.3420	0.9397	-0.1750
3	2	13	0.1750	120.0000	-0.5000	0.8660	-0.1750
3	2	14	0.1750	130.0000	-0.6428	0.7660	-0.1750
3	2	15	0.1750	140.0000	-0.7660	0.6428	-0.1750
3	2	16	0.1750	150.0000	-0.8660	0.5000	-0.1750
3	2	17	0.1750	160.0000	-0.9397	0.3420	-0.1750
3	2	18	0.1750	170.0000	-0.9848	0.1736	-0.1750
3	2	19	0.1750	180.0000	-1.0000	0.0000	-0.1750
3	2	20	0.1750	190.0000	-0.9848	-0.1736	-0.1750
3	2	21	0.1750	200.0000	-0.9397	-0.3420	-0.1750
3	2	22	0.1750	210.0000	-0.8660	-0.5000	-0.1750
3	2	23	0.1750	220.0000	-0.7660	-0.6428	-0.1750
3	2	24	0.1750	230.0000	-0.6428	-0.7660	-0.1750
3	2	25	0.1750	240.0000	-0.5000	-0.8660	-0.1750
3	2	26	0.1750	250.0000	-0.3420	-0.9397	-0.1750
3	2	27	0.1750	260.0000	-0.1736	-0.9848	-0.1750
3	2	28	0.1750	270.0000	0.0000	-1.0000	-0.1750
3	2	29	0.1750	280.0000	0.1736	-0.9848	-0.1750
3	2	30	0.1750	290.0000	0.3420	-0.9397	-0.1750
3	2	31	0.1750	300.0000	0.5000	-0.8660	-0.1750
3	2	32	0.1750	310.0000	0.6428	-0.7660	-0.1750
3	2	33	0.1750	320.0000	0.7660	-0.6428	-0.1750
3	2	34	0.1750	330.0000	0.8660	-0.5000	-0.1750
3	2	35	0.1750	340.0000	0.9397	-0.3420	-0.1750
3	2	36	0.1750	350.0000	0.9848	-0.1736	-0.1750
3	2	37	0.1750	360.0000	1.0000	0.0000	-0.1750

BOUNDARY LINE	MESH ROW	MESH COL	SURFACE X	SURFACE Y	GLOBAL CARTESIAN XG	GLOBAL CARTESIAN YG	GLOBAL CARTESIAN ZG
4	1	1	0.0000	0.0000	1.0000	0.0000	0.0000
4	2	1	0.1750	0.0000	1.0000	0.0000	-0.1750

BOUNDARY CONDITIONS

BOUNDARY CONDITION AT LINE 1 IS SYMMETRIC
BOUNDARY CONDITION AT LINE 2 IS JUNCTURE
BOUNDARY CONDITION AT LINE 3 IS SYMMETRIC
BOUNDARY CONDITION AT LINE 4 IS UNRESTRAINED

SHELL UNIT WALL PROPERTIES (UNIT 1)

	X	Y
T E	0.3567E-01	0.2038E+01

TYPE	NLAY	NLIP	ISL	ISS	ISD	ZE
GENERAL LAYERED	1	0	0	0	0	0.00000

LAYER	MATL	THICKNESS	ZETL	LSO
1	1	0.10000E-01	0.00000E+00	0

CONSTITUTIVE MATRIX,CIJ

	(NX)	(NY)	(NXY)	(MX)	(MY)	(MXY)
(EX)	0.107830E+01	0.323489E+00	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
(EY)		0.107830E+01	0.000000E+00	0.000000E+00	0.000000E+00	0.000000E+00
(EXY)			0.377404E+00	0.000000E+00	0.000000E+00	0.000000E+00
(KX)				0.898581E-05	0.269574E-05	0.000000E+00
(KY)					0.898581E-05	0.000000E+00
(KXY)						0.314503E-05

UNIT 1 PRE-PROCESSING SUMMARY

ELEMENTS	GEOMETRIC RELS	CONSTITUTIVE RELS	WEIGHT INCREMENT	NEW GROSS WEIGHT	
SHLL		LINEAR	ELASTIC	0.8621E-01	0.8621E-01

UNIT 1 LOAD,SUMMARY

LOAD SYSTEMS NSYS	INITIAL CONDITIONS NICS	ATTACHED MASSES NAMAS	PRESTRESS NPRST
0	0	0	0

OUTPUT CONTROL PARAMATERS

DISPL IPRD	STRS RESUL IPRR	STRAINS IPRE	STRESSES IPRS	PLAS STR IPRP	REACTIONS IPRF
0	0	0	0	0	0

IPRSDP	IPRSTR
0	0

COMPUTATIONAL DOF ASSIGNMENTS

UNIT	ROW	COL	U	V	W	RU	RV	RW	MID1	MID2	MID3
1	1	1	0	1	2	3	0	0			
1	2	1	0	4	5	6	0	0			
1	1	2	0	7	8	9	0	0			
1	2	2	0	10	11	12	0	0			
1	1	3	0	13	14	15	0	0			
1	2	3	0	16	17	18	0	0			
1	1	4	0	19	20	21	0	0			
1	2	4	0	22	23	24	0	0			
1	1	5	0	25	26	27	0	0			
1	2	5	0	28	29	30	0	0			
1	1	6	0	31	32	33	0	0			
1	2	6	0	34	35	36	0	0			
1	1	7	0	37	38	39	0	0			
1	2	7	0	40	41	42	0	0			
1	1	8	0	43	44	45	0	0			
1	2	8	0	46	47	48	0	0			
1	1	9	0	49	50	51	0	0			
1	2	9	0	52	53	54	0	0			
1	1	10	0	55	56	57	0	0			
1	2	10	0	58	59	60	0	0			

1	1	11	0	61	62	63	0	0
1	2	11	0	64	65	66	0	0
1	1	12	0	67	68	69	0	0
1	2	12	0	70	71	72	0	0
1	1	13	0	73	74	75	0	0
1	2	13	0	76	77	78	0	0
1	1	14	0	79	80	81	0	0
1	2	14	0	82	83	84	0	0
1	1	15	0	85	86	87	0	0
1	2	15	0	88	89	90	0	0
1	1	16	0	91	92	93	0	0
1	2	16	0	94	95	96	0	0
1	1	17	0	97	98	95	0	0
1	2	17	0	100	101	102	0	0
1	1	18	0	103	104	105	0	0
1	2	18	0	106	107	108	0	0
1	1	19	0	109	110	111	0	0
1	2	19	0	112	113	114	0	0
1	1	20	0	115	116	117	0	0
1	2	20	0	118	119	120	0	0
1	1	21	0	121	122	123	0	0
1	2	21	0	124	125	126	0	0
1	1	22	0	127	128	129	0	0
1	2	22	0	130	131	132	0	0
1	1	23	0	133	134	135	0	0
1	2	23	0	136	137	138	0	0
1	1	24	0	139	140	141	0	0
1	2	24	0	142	143	144	0	0
1	1	25	0	145	146	147	0	0
1	2	25	0	148	149	150	0	0
1	1	26	0	151	152	153	0	0
1	2	26	0	154	155	156	0	0
1	1	27	0	157	158	159	0	0
1	2	27	0	160	161	162	0	0
1	1	28	0	163	164	165	0	0
1	2	28	0	166	167	168	0	0
1	1	29	0	169	170	171	0	0
1	2	29	0	172	173	174	0	0
1	1	30	0	175	176	177	0	0
1	2	30	0	178	179	180	0	0
1	1	31	0	181	182	183	0	0
1	2	31	0	184	185	186	0	0
1	1	32	0	187	188	189	0	0
1	2	32	0	190	191	192	0	0
1	1	33	0	193	194	195	0	0
1	2	33	0	196	197	198	0	0
1	1	34	0	199	200	201	0	0
1	2	34	0	202	203	204	0	0
1	1	35	0	205	206	207	0	0
1	2	35	0	208	209	210	0	0
1	1	36	0	211	212	213	0	0

1	2	36	0	214	215	216	0	0
1	1	37	0	1	2	3	0	0
1	2	37	0	4	5	6	0	0

PREPROCESSING SUMMARY

NO. OF UNITS	NO. OF D.O.F. (TOTAL)	NO. OF D.O.F. (ACTIVE)
1	518	216

```
 U S A - S T A G S   PRE-PROCESSING . . .

+++  OPEN,    3 = FOR003                  , Acc= SEQUENT, Stat= NEW
+++  Form = UNFORMATTED
+++  OPEN,    4 = FOR004                  , Acc= SEQUENT, Stat= NEW
+++  Form = UNFORMATTED
```

STRUCTURAL NODE LIST,   72 NODES

NODE	XG	YG	ZG
1	0.100000E+01	0.000000E+00	-0.437114E-07
2	0.984808E+00	0.173648E+00	-0.430473E-07
3	0.939693E+00	0.342020E+00	-0.410753E-07
4	0.866025E+00	0.500000E+00	-0.378552E-07
5	0.766044E+00	0.642788E+00	-0.334849E-07
6	0.642788E+00	0.766044E+00	-0.280971E-07
7	0.500000E+00	0.866025E+00	-0.218557E-07
8	0.342020E+00	0.939693E+00	-0.149502E-07
9	0.173648E+00	0.984808E+00	-0.759041E-08
10	-0.437114E-07	0.100000E+01	0.191069E-14
11	-0.173648E+00	0.984808E+00	0.759040E-08
12	-0.342020E+00	0.939693E+00	0.149502E-07
13	-0.500000E+00	0.866025E+00	0.218557E-07
14	-0.642788E+00	0.766044E+00	0.280971E-07
15	-0.766044E+00	0.642788E+00	0.334849E-07
16	-0.866025E+00	0.500000E+00	0.378552E-07
17	-0.939693E+00	0.342020E+00	0.410753E-07
18	-0.984808E+00	0.173648E+00	0.430473E-07
19	-0.100000E+01	-0.874228E-07	0.437114E-07
20	-0.984808E+00	-0.173648E+00	0.430473E-07
21	-0.939693E+00	-0.342020E+00	0.410753E-07
22	-0.866025E+00	-0.500000E+00	0.378552E-07
23	-0.766044E+00	-0.642788E+00	0.334849E-07
24	-0.642788E+00	-0.766045E+00	0.280971E-07
25	-0.500000E+00	-0.866025E+00	0.218557E-07
26	-0.342020E+00	-0.939693E+00	0.149502E-07
27	-0.173648E+00	-0.984808E+00	0.759040E-08
28	0.119249E-07	-0.100000E+01	-0.521253E-15
29	0.173648E+00	-0.984808E+00	-0.759040E-08
30	0.342020E+00	-0.939693E+00	-0.149502E-07
31	0.500000E+00	-0.866025E+00	-0.218557E-07

32	0.6427[illegible]	-0.766044E+00	-0.280971E-07
33	0.766044E+00	-0.642788E+00	-0.334849E-07
34	0.866025E+00	-0.500000E+00	-0.378552E-07
35	0.939693E+00	-0.342020E+00	-0.410753E-07
36	0.984808E+00	-0.173648E+00	-0.430473E-07
37	0.100000E+01	0.000000E+00	-0.175000E+00
38	0.984808E+00	0.173648E+00	-0.175000E+00
39	0.939693E+00	0.342020E+00	-0.175000E+00
40	0.866025E+00	0.500000E+00	-0.175000E+00
41	0.766044E+00	0.642788E+00	-0.175000E+00
42	0.642788E+00	0.766044E+00	-0.175000E+00
43	0.500000E+00	0.866025E+00	-0.175000E+00
44	0.342020E+00	0.939693E+00	-0.175000E+00
45	0.173648E+00	0.984808E+00	-0.175000E+00
46	-0.513609E-07	0.100000E+01	-0.175000E+00
47	-0.173648E+00	0.984808E+00	-0.175000E+00
48	-0.342020E+00	0.939693E+00	-0.175000E+00
49	-0.500000E+00	0.866025E+00	-0.175000E+00
50	-0.642788E+00	0.766044E+00	-0.175000E+00
51	-0.766044E+00	0.642788E+00	-0.175000E+00
52	-0.866025E+00	0.500000E+00	-0.175000E+00
53	-0.939693E+00	0.342020E+00	-0.175000E+00
54	-0.984808E+00	0.173648E+00	-0.175000E+00
55	-0.100000E+01	-0.874228E-07	-0.175000E+00
56	-0.984808E+00	-0.173648E+00	-0.175000E+00
57	-0.939693E+00	-0.342020E+00	-0.175000E+00
58	-0.866025E+00	-0.500000E+00	-0.175000E+00
59	-0.766044E+00	-0.642788E+00	-0.175000E+00
60	-0.642788E+00	-0.766045E+00	-0.175000E+00
61	-0.500000E+00	-0.866025E+00	-0.175000E+00
62	-0.342020E+00	-0.939693E+00	-0.175000E+00
63	-0.173648E+00	-0.984808E+00	-0.175000E+00
64	0.427539E-08	-0.100000E+01	-0.175000E+00
65	0.173648E+00	-0.984808E+00	-0.175000E+00
66	0.342020E+00	-0.939693E+00	-0.175000E+00
67	0.500000E+00	-0.866025E+00	-0.175000E+00
68	0.642788E+00	-0.766044E+00	-0.175000E+00
69	0.766044E+00	-0.642788E+00	-0.175000E+00
70	0.866025E+00	-0.500000E+00	-0.175000E+00
71	0.939693E+06	-0.342020E+00	-0.175000E+00
72	0.984808E+00	-0.173648E+00	-0.175000E+00

NDOF = 432 DIAGONAL MASS MATRIX (GLOBAL)

0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578407E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06

0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
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0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
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0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578407E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578407E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-0[illegible]	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06

0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578405E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578406E-06	0.285337E-06
0.119730E-02	0.119730E-02	0.119730E-02	0.582905E-06	0.578407E-06	0.285337E-06

NDOF = 432 DOF IDENTIFICATION VECTOR

11	12	13	14	15	16	21	22	23	24
25	26	31	32	33	34	35	36	41	42
43	44	45	46	51	52	53	54	55	56
61	62	63	64	65	66	71	72	73	74
75	76	81	82	83	84	85	86	91	92
93	94	95	96	101	102	103	104	105	106
111	112	113	114	115	116	121	122	123	124
125	126	131	132	133	134	135	136	141	142
143	144	145	146	151	152	153	154	155	156
161	162	163	164	165	166	171	172	173	174
175	176	181	182	183	184	185	186	191	192
193	194	195	196	201	202	203	204	205	206
211	212	213	214	215	216	221	222	223	224
225	226	231	232	233	234	235	236	241	242
243	244	245	246	251	252	253	254	255	256
261	262	263	264	265	266	271	272	273	274
275	276	281	282	283	284	285	286	291	292
293	294	295	296	301	302	303	304	305	306
311	312	313	314	315	316	321	322	323	324
325	326	331	332	333	334	335	336	341	342
343	344	345	346	351	352	353	354	355	356
361	362	363	364	365	366	371	372	373	374
375	376	361	382	383	384	385	386	391	392
393	394	395	396	401	402	403	404	405	406
411	412	413	414	415	416	421	422	423	424
425	426	431	432	433	434	435	436	441	442
443	444	445	446	451	452	453	454	455	456
461	462	463	464	465	466	471	472	473	474
475	476	481	482	483	484	485	486	491	492
493	494	495	496	501	502	503	504	505	506
511	512	513	514	515	516	521	522	523	524
525	526	531	532	533	534	535	536	541	542
543	544	545	546	551	552	553	554	555	556
561	562	563	564	565	566	571	572	573	574

575	576	581	582	583	584	585	586	591	592
593	594	595	596	601	602	603	604	605	606
611	612	613	614	615	616	621	622	623	624
625	626	631	632	633	634	635	636	641	642
643	644	645	646	651	652	653	654	655	656
661	662	663	664	665	666	671	672	673	674
675	676	681	682	683	684	685	686	691	692
693	694	695	696	701	702	703	704	705	706
711	712	713	714	715	716	721	722	723	724
725	726								

ELEMENT LIST FOR UNIT 1

ELEMENT	TYPE	NODES	(COUNTERCLOCKWISE	ORDER)	
1	410	1	37	38	2
2	410	2	38	39	3
3	410	3	39	40	4
4	410	4	40	41	5
5	410	5	41	42	6
6	410	6	42	43	7
7	410	7	43	44	8
8	410	8	44	45	9
9	410	9	45	46	10
10	410	10	46	47	11
11	410	11	47	48	12
12	410	12	48	49	13
13	410	13	49	50	14
14	410	14	50	51	15
15	410	15	51	52	16
16	410	16	52	53	17
17	410	17	53	54	18
18	410	18	54	55	19
19	410	19	55	56	20
20	410	20	56	57	21
21	410	21	57	58	22
22	410	22	58	59	23
23	410	23	59	60	24
24	410	24	60	61	25
25	410	25	61	62	26
26	410	26	62	63	27
27	410	27	63	64	28
28	410	28	64	65	29
29	410	29	65	66	30
30	410	30	66	67	31
31	410	31	67	68	32
32	410	32	68	69	33
33	410	33	69	70	34
34	410	34	70	71	35

```
    35     410              35    71    72    36
    36     410              36    72    37     1

 NODAL COORDINATES SAVED ON UNIT  3  --  USC
 MASS/DOF VECTORS  SAVED ON UNIT  4  --  USD
.....................................................................

+++  CLOSE,  3
+++  CLOSE,  4

                   FLOATING POINT OPERATION COUNT
        NEQ      NFLOPS    NONZEROS
        216       26748        3240

AVERAGE SEMI-BANDWIDTH =      15


ESTIMATED FACTORIZATION TIME     0.040223  SECONDS.


STAGS1 MASS STORAGE STATISTICS
------------------------------
   FILE NAME    FILE LENGTH    FILE FUNCTION
           1           2436    CONFIGURATION
           2            585    DOF ASSIGNMENT
           3            713    LOADS
           4            585    MASSES
           5             32    RESOURCES
      FMDATA          20012    VARIATION DATA
      FMDATA           1944    GLOBAL VECTORS

CALCULATION OF ELEMENT INTERPOLATION AND CONSTITUTIVE MATRICES COMPLETE.

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+            A U X I L I A R Y   S T O R A G E   T A B L E          +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                   +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc   Next  Limit     Read Written +
+  8 FOR010       10  1 T    64    333    478 100000    50226   56448 +
+                                                                   +
+                     1 Active devices ( 0 full)                    +
+     0 Tp ops,     22 Writes,     19 Reads       106674 Words XFD  +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE, 10

$$ ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
   5.171094E+01               41                106674            30528
```

APPENDIX C

USER INFORMATION FOR THE FLUID PREPROCESSOR FLUMAS

This appendix includes a copy of the users manual, and a sample input deck and subsequent output for the infinite cylindrical shell problem presented in Section 4.

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                         F  L  U  M  A  S

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     THIS FUNCTIONAL COMPONENT OF THE UNDERWATER SHOCK ANALYSIS CODE
     CONSTRUCTS THE FLUID MASS MATRIX FOR A STRUCTURE SUBMERGED IN AN
     INFINITE, INVISCID, INCOMPRESSIBLE FLUID BY THE BOUNDARY ELEMENT
     TECHNIQUE. IT ALSO GENERATES FLUID MESH DATA AND A SET OF
     TRANSFORMATION COEFFICIENTS THAT RELATE THE STRUCTURAL AND FLUID
     DEGREES OF FREEDOM ON THE WET SURFACE. THE CODE HAS THE CAPABILITY
     TO TREAT STRUCTURES CONTAINING BOTH SURFACE-OF-REVOLUTION (SOR)
     AND GENERAL-GEOMETRY (GEN) COMPONENTS. THE CODE CAN CONSTRUCT THE
     FLUID MASS MATRIX FOR BOTH QUARTER AND HALF MODELS WITH
     ARBITRARILY ASSIGNED SYMMETRY OR ANTISYMMETRY CONDITIONS, AND CAN
     SIMULATE THE TWO-DIMENSIONAL PLANE STRAIN BEHAVIOR OF LONG
     CYLINDERS. THE PRESENCE OF A FREE SURFACE IN THE VICINITY OF THE
     SUBMERGED STRUCTURE CAN ALSO BE ACCOUNTED FOR. A VERY USEFUL
     DIAGNOSTIC TOOL CONTAINED WITHIN THE CODE IS THE ABILITY TO SOLVE
     THE FLUID BOUNDARY MODE EIGENVALUE PROBLEM

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     THIS PROGRAM WAS DEVELOPED AND CODED BY JOHN A. DERUNTZ, JR.
     OF LOCKHEED MISSILES AND SPACE CO. RESEARCH LABS IN PALO ALTO
     CALIFORNIA. PLEASE CONSULT WITH AUTHOR BEFORE MAKING CHANGES
     AND ALSO REPORT ANY MALFUNCTIONS OR PROBLEMS. WRITE IN CARE OF
     LOCKHEED PALO ALTO RESEARCH LABORATORY, BLDG 205, DEPT 52-33,
     3251 HANOVER ST., PALO ALTO, CALIF., 94304 OR CALL 415-493-4411
     EXTS. 45069 OR 45133.                            SEPTEMBER, 1980

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                   M A X I M U M     V A L U E S

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     MAXIMUM NUMBER OF STRUCTURAL GRID POINTS        . . . . . . .   1 0 0 0

     MAXIMUM NUMBER OF GENERAL SURFACE ELEMENTS      . . . . . . . .   4 0 0

     MAXIMUM NUMBER OF SURFACE OF REVOLUTION SEGMENTS    . . . . . .   2 0 0

     MAXIMUM NUMBER OF SURFACE OF REVOLUTION BRANCHES    . . . . . .       6

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  W A R N I N G    F R O M    T H E    P R O G R A M M E R    G E N E R A L

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     THIS CODE CONTAINS THE SPECIAL INGREDIENT DMGASP NOT FOUND IN
     OTHER BRANDS. DMGASP IS A DATA MANAGEMENT UTILITY MODULE THAT
     WILL ACTIVATE AND DEACTIVATE ALL AUXILIARY STORAGE DATA FILES
     REFERENCED BY THE CODE. HENCE THE NAMES OF SUCH FILES SHOULD NOT
     APPEAR ON ANY CONTROL CARDS IN THE RUN STREAM WHICH MIGHT NORMALLY
     ACTIVATE AND DEACTIVATE THE FILES. THE USER IS ALSO CAUTIONED THAT
```

PREVIOUSLY CREATED FILES MUST ALREADY BE RESIDENT IN THE SYSTEM BEFORE THE RUN IS INITIATED. IF A FILE HAS BEEN ROLLED-OUT TO TAPE DMGASP WILL ATTEMPT TO HAVE THE FILE ROLLED-IN EVERY 15 SECONDS FOR UP TO 6 MINUTES ON THE UNIVAC 1100-EXEC 8 OPERATING SYSTEM. IF AN EXISTING DATA FILE HAS NOT BEEN REFERENCED FOR SOME TIME IT IS THEREFORE GOOD POLICY TO SIMPLY ACTIVATE AND DEACTIVATE THE FILE BEFORE EXECUTION OF THIS CODE. IF THE USER ATTEMPTS TO CREATE A NEW DATA FILE WITH A NAME WHICH IS ALREADY ASSIGNED TO AN EXISTING FILE, THE UNIVAC VERSION OF DMGASP WILL MODIFY THE NAME OF THE FILE GENERATED BY THIS RUN TO AVOID ANY CONFLICT. FILE NAME DUPLICATION WILL CAUSE NO PROBLEM ON THE CDC SCOPE OPERATING SYSTEM AS SCOPE WILL SIMPLY CATALOG A NEW CYCLE OF THE SAME FILE. ON THE OTHER HAND THE CDC NOS SYSTEM IS SIMILAR TO UNIVAC IN THIS REGARD AND THE RUN WILL ABORT SINCE THE NAME-CHANGING FEATURE OF DMGASP HAS NOT BEEN IMPLEMENTED FOR NOS. QUALIFIER*FILENAME IS THE REQUIRED INPUT DATA FORMAT FOR ALL UNIVAC PERMANENT FILE NAMES. ON CDC SCOPE, THE QUALIFIER IS INTERPRETED AS THE USERS ID, WHICH IN MOST INSTALLATIONS CAN BE SELECTED ALMOST ARBITRARILY. ON CDC NOS, THE QUALIFIER IS INTERPRETED AS THE USERS CATALOG NUMBER, WHICH IS USUALLY PRESCRIBED BY THE INSTALLATION. A CYCLE NUMBER CAN ALSO BE APPENDED TO GIVE THE FORM QUALIFIER*FILENAME(CYCLE) ON CDC SCOPE

* *

P R O G R A M   S I Z E

* *

ALL ARRAYS REFERRENCED IN THIS CODE THAT ARE PROBLEM DEPENDENT RESIDE IN BLANK COMMON. THE SIZE OF BLANK COMMON IS DETERMINED BY A PARAMETER STATEMENT IN THE MAIN PROGRAM FOR THE UNIVAC 1100-OS VERSION, HENCE A RECOMPILATION IS NECESSARY TO INCREASE OR DECREASE CORE ALLOCATION. IN THE CDC 6600 VERSION RECOMPILATION IS UNNECESSARY AS THE LENGTH OF BLANK COMMON IS SET BY A FIELD LENGTH REQUEST IN THE CONTROL CARD DECK

* *

D E F I N I T I O N   O F   I N P U T   P A R A M E T E R S

* *

INPUT VARIABLE NAMES GIVEN BELOW ARE GENERALLY THOSE WHICH ARE ALSO USED IN THE CODING AND THE VARIABLE TYPES CORRESPOND TO STANDARD FORTRAN USAGE:

A - ALPHANUMERIC
E - FLOATING POINT
F - FIXED POINT
I - INTEGER
L - LOGICAL

VARIABLE	TYPE	DESCRIPTION
NSTRC	I	NUMBER OF STRUCTURAL NODE OR GRID POINTS

		WHOSE GLOBAL COORDINATES ARE TO BE READ AS INPUT DATA FROM CARDS. AT THE VERY LEAST THE SUM OF NSTRC AND NSTRF (SEE BELOW) MUST INCLUDE ALL THE WET NODES, IE., THOSE LYING ON THE FLUID-STRUCTURE CONTACT BOUNDARY. IF THE ULTIMATE PURPOSE OF THIS RUN IS TO CONDUCT AN UNDERWATER SHOCK ANALYSIS WITH THE USA CODE FOR THE STRUCTURE IN QUESTION THEN IT IS ADVISABLE TO INCLUDE IN THE INPUT TO THIS PROCESSOR ALL OF THE INTERNAL OR DRY STRUCTURAL NODE POINTS AS WELL IN ORDER TO FACILITATE POST PROCESSING OF THE TRANSIENT RESPONSE ANALYSIS FOR THE DRY STRUCTURE. THIS NUMBER MAY ALSO INCLUDE ADDITIONAL NODE POINTS THAT ARE NOT PART OF THE STRUCTURAL MODEL BUT WHICH ARE NECESSARY TO DEFINE THE FLUID MESH. HOWEVER SUCH ADDITIONAL NODES SHOULD APPEAR LAST AS THEY ARE NOT REQUIRED BY ANY OTHER USA PROCESSOR AND ARE THEREFORE ULTIMATELY DELETED
NSTRF	I	NUMBER OF STRUCTURAL NODE OR GRID POINTS WHOSE GLOBAL COORDINATES ARE TO BE READ FROM A PERMANENT FILE (SEE GRDNAM). ADDITIONAL NODE POINTS THAT ARE NOT PART OF THE STRUCTURAL MODEL ARE NOT PERMITTED IN THIS DATA SET IF ACTUAL STRUCTURAL NODE POINT DATA IS ALSO INPUT FROM CARDS. THIS IS DUE TO THE FACT THAT THE FILE DATA IS READ FIRST THEN THE DATA FROM CARDS AND ANY ADDITIONAL NON-STRUCTURAL NODE POINTS MUST APPEAR LAST IN THE GRID POINT LIST. THIS FILE MUST ALWAYS BE REFERENCED WHEN INTERFACING WITH STAGS
NGEN	I	NUMBER OF GENERAL FLUID DEGREES OF FREEDOM WHOSE ASSOCIATED ELEMENTS CANNOT BE FORMED BY AN AUTOMATIC MESH GENERATION PROCEDURE
NBRA	I	NUMBER OF DISTINCT SURFACE OF REVOLUTION AXES OR BRANCHES
NCYL	I	NUMBER OF GENERAL FLUID CONTROL POINTS WHICH LIE ON A RIGHT CIRCULAR CYLINDRICAL SURFACE WHOSE ASSOCIATED RECTANGULAR ELEMENTS COVER THE ENTIRE LATERAL SURFACE. SUCH ELEMENTS CAN BE FORMED BY AN AUTOMATIC MESH GENERATION SCHEME WHICH IS EMBEDDED IN THE CODE. STRUCTURAL GRID POINT COORDINATES NEED NOT BE INPUT IN THIS CASE UNLESS DICTATED BY OTHER CIRCUMSTANCES
NHAS	I	STARTING CIRCUMFERENTIAL HARMONIC FOR SURFACE OF REVOLUTION ELEMENTS
NHAF	I	FINAL CIRCUMFERENTIAL HARMONIC FOR

```
                                SURFACE OF REVOLUTION ELEMENTS

           NHAI       I         INCREMENT TO BE APPLIED IN ASSIGNING
                                CIRCUMFERENTIAL HARMONICS IN THE RANGE
                                FROM NHAS TO NHAF

           NFUN       I         NUMBER OF TRIGONOMETRIC FUNCTIONS THAT
                                WILL BE USED IN ASSIGNING SURFACE OF
                                REVOLUTION FLUID DEGREES OF FREEDOM.
                                PERMISSIBLE VALUES ARE:

                                  1 - EITHER SINE OR COSINE WILL BE USED
                                      ACCORDING TO VALUE OF ITRG DESCRIBED
                                      BELOW
                                  2 - BOTH SINE AND COSINE FUNCTIONS WILL
                                      BE USED

           ITRG       I         IF NFUN = 1 ITRG DESIGNATES THE PARTICULAR
                                TRIGONOMETRIC FUNCTION TO BE USED FOR
                                SURFACE OF REVOLUTION FLUID DEGREES OF
                                FREEDOM. ALLOWABLE VALUES ARE:

                                  1 - COSINE FUNCTION IS USED
                                  2 - SINE FUNCTION IS USED

           NSEG       I         NUMBER OF SURFACE OF REVOLUTION SEGMENTS
                                ALONG ANY PARTICULAR AXIS OR BRANCH

           NCIR       I         NUMBER OF SUB-ELEMENTS AROUND THE
                                CIRCUMFERENCE OF A SURFACE OF REVOLUTION
                                BRANCH. UNDER NORMAL CONDITIONS USE A
                                VALUE OF ZERO AND THE CODE WILL CHOOSE AN
                                APPROPRIATE VALUE BASED UPON THE ASPECT
                                RATIO OF THE SUB-ELEMENT. A MINIMUM OF
                                TWELVE (12) IS ALLOWED AND NCIR IS ALWAYS
                                A MULTIPLE OF FOUR (4). USE A NON-ZERO
                                VALUE ONLY UNDER SPECIAL CIRCUMSTANCES AND
                                ADHERE TO THESE GUIDELINES

           RHO        E,F       FLUID MASS DENSITY

           CEE        E,F       FLUID SPEED OF SOUND

           DAA2       E,F       A PARAMETER BOUNDED BY ZERO AND UNITY THAT
                                GOVERNS THE USE OF THE IMPROVED DOUBLY
                                ASYMPTOTIC APPROXIMATION. A VALUE OF ZERO
                                REDUCES THE FLUID SOLUTION TO THE STANDARD
                                DOUBLY ASYMPTOTIC APPROXIMATION. HOWEVER A
                                PRECISE CHOICE FOR THIS PARAMETER IS NOT
                                GIVEN BY ANY FUNDAMENTAL PRINCIPLE. IT HAS
                                BEEN OBSERVED THAT A VALUE OF 1.0 LEADS TO
                                THE BEST ACCURACY FOR A SPHERICAL SHELL
                                WHILE A VALUE OF 0.5 SEEMS TO BE BEST FOR
                                THE INFINITE CYLINDRICAL SHELL. IT CAN BE
                                SHOWN THAT THIS SCALAR PARAMETER DOES HAVE
                                A RELATIONSHIP WITH THE DIAGONAL LOCAL
                                CURVATURE MATRIX FOR THE FLUID ELEMENTS.
                                IF DAA2 RUNS ARE CONTEMPLATED AS WELL AS
```

```
                          DAA1 RUNS IT IS ADVISEABLE TO ENTER A
                          NONZERO VALUE AND THE PRECISE VALUE CAN BE
                          CHANGED LATER IN THE AUGMAT PROCESSOR IF
                          NECESSARY. IF A ZERO VALUE IS ENTERED THEN
                          TWO MATRICES REQUIRED FOR DAA2 EXECUTION
                          ARE NOT EVEN CONSTRUCTED

       PRTGMT     L       TRUE IF FLUID MESH GEOMETRY DATA IS TO BE
                          LISTED, OTHERWISE FALSE

       PRTTRN     L       TRUE IF FLUID-STRUCTURE TRANSFORMATION
                          DATA IS TO BE LISTED, OTHERWISE FALSE

       PRTAMF     L       TRUE IF FLUID MASS MATRIX IS TO BE LISTED,
                          OTHERWISE FALSE IN WHICH CASE ONLY THE
                          DIAGONAL TERMS ARE PRINTED. THIS PARAMETER
                          ALSO GOVERNS THE PRINTING OF THE MATRIX
                          THAT APPEARS IN THE DAA EQUATIONS

       CALCAM     L       TRUE IF THE FLUID MASS MATRIX IS TO BE
                          COMPUTED, OTHERWISE FALSE AND THE RUN WILL
                          TERMINATE AFTER THE FLUID MESH GEOMETRY
                          DATA HAS BEEN PROCESSED. USE A VALUE OF
                          TRUE ONLY AFTER DEBUGGING OF THE GEOMETRY
                          DATA HAS BEEN COMPLETED

       PRTCOE     L       TRUE IF THE B AND C MATRICES ARE TO BE
                          PRINTED FOR SOME DIAGNOSTIC REASON,
                          OTHERWISE FALSE UNDER NORMAL OPERATING
                          CONDITIONS. THESE MATRICES ARE FULL AND
                          GENERALLY NONSYMMETRIC. THE PRODUCT B*CINV
                          IS THE PRINCIPAL COMPUTATION THAT IS
                          REQUIRED TO FORM THE FLUID MASS MATRIX
                          (SEE DERUNTZ AND GEERS, ADDED MASS
                          COMPUTATION BY THE BOUNDARY INTEGRAL
                          METHOD, INT J NUM METH, VOL 12, 1978, PP
                          531-550)

       EIGMAF     L       TRUE IF EIGENVALUES AND EIGENVECTORS OF
                          THE FLUID BOUNDARY MODE PROBLEM ARE
                          DESIRED, OTHERWISE FALSE. THE PRESENCE OF
                          NEGATIVE EIGENVALUES IS AN INDICATION THAT
                          THE FLUID MESH IS IN ERROR, HENCE THIS CAN
                          BE AN IMPORTANT DEBUGGING TOOL

       TWODIM     L       TRUE IF A TWO DIMENSIONAL PLANE STRAIN
                          FLUID MASS MATRIX IS REQUIRED, OTHERWISE
                          FALSE. THE Z DIRECTION MUST BE
                          PERPENDICULAR TO THE PLANE OF THE FLUID
                          MODEL. IF THIS IS NOT SO A TEMPORARY OR
                          PERMANENT COORDINATE ROTATION CAN BE
                          APPLIED FOR COMPUTATION OF THE MATRIX (SEE
                          ROTQUA OR ROTGEO)

       HAFMOD     L       TRUE IF THE FLUID MESH INPUT GEOMETRY
                          CORRESPONDS TO A HALF MODEL, OTHERWISE
                          FALSE. THE VARIABLES DEPTH, CXFS, CYFS,
                          AND CZFS ARE USED TO DEFINE THE LOCATION
```

		AND ORIENTATION OF THE SYMMETRY PLANE. THIS OPTION CANNOT BE USED SIMULTANEOUSLY WITH FRESUR = .TRUE.
QUAMOD	L	TRUE IF THE FLUID MESH INPUT GEOMETRY CORRESPONDS TO A QUARTER MODEL, OTHERWISE FALSE. THE XZ AND YZ PLANES ARE CONSIDERED TO BE THE PLANES OF SYMMETRY OF THE MODEL BY DEFAULT. IF NECESSARY A COORDINATE ROTATION CAN BE APPLIED TO SATISFY THIS REQUIREMENT (SEE ROTQUA BELOW). IF NCYL IS NOT EQUAL TO ZERO SUCH A ROTATION MUST BE USED IN CONJUNCTION WITH THE QUARTER MODEL. THIS ROTATION WILL NOT AFFECT THE ORIENTATION OF THE FLUID MESH REFERENCE AXES IN SUBSEQUENT USA PROCESSING
PCHCDS	L	TRUE IF THE DIAGONAL GENERALIZED AREA MATRIX IS TO BE PUNCHED OUT ON CARDS FOR INPUT TO NASTRAN, OTHERWISE FALSE
NASTAM	L	TRUE IF THE FLUID MASS MATRIX OR ITS MANIPULATED FORM WHICH APPEARS IN THE DAA EQUATION IS TO BE PUT IN THE PERMANENT FILE DESIGNATED BY FLUNAM IN A FORMAT WHICH CAN BE READ BY NASTRAN, OTHERWISE FALSE
STOMAS	L	TRUE IF THE FLUID MASS MATRIX ITSELF IS TO BE PUT IN PERMANENT STORAGE, OTHERWISE FALSE. IN CONTRAST TO EARLIER VERSIONS OF THIS CODE THIS PARAMETER CAN BE SET TO FALSE FOR NORMAL OPERATION OF THE USA CODE
STOINV	L	TRUE IF THE MANIPULATED FORM OF THE FLUID MASS MATRIX WHICH APPEARS IN THE DAA EQUATION IS TO BE PUT IN PERMANENT STORAGE, OTHERWISE FALSE. THIS MATRIX CONSISTS OF THE INVERTED FLUID MASS MATRIX THAT HAS BEEN PRE- AND POST-MULTIPLIED BY THE DIAGONAL FLUID ELEMENT AREA MATRIX AND THEN MULTIPLIED BY BOTH THE MASS DENSITY AND THE SPEED OF SOUND OF THE FLUID. IN CONTRAST WITH EARLIER VERSIONS OF THIS CODE THIS PARAMETER MUST BE SET TO TRUE FOR NORMAL OPERATION OF THE USA CODE
FRWTFL	L	TRUE IF THE PERMANENT FILE CONTAINING THE FLUID MASS MATRIX OR ITS MANIPULATED FORM IS TO BE CREATED BY BUFFERED, UNFORMATTED FORTRAN WRITE STATEMENTS, OTHERWISE FALSE AND DMGASP WILL CREATE THE FILE
FRWTGE	L	TRUE IF THE PERMANENT FILE CONTAINING THE FLUID MESH GEOMETRY IS TO BE CREATED BY BUFFERED, UNFORMATTED FORTRAN WRITE STATEMENTS, OTHERWISE FALSE AND DMGASP WILL CREATE THE FILE

```
FRWTGR      L      TRUE IF THE PERMANENT FILE CONTAINING
                   STRUCTURAL GRID POINT COORDINATES HAS
                   BEEN CREATED BY BUFFERED, UNFORMATTED
                   FORTRAN WRITE STATEMENTS, OTHERWISE FALSE
                   IN WHICH CASE IT IS ASSUMED THAT DMGASP
                   WAS USED TO CREATE THE FILE. CONSULT A
                   LISTING OF THE SUBROUTINE READST FOR THE
                   FILE STRUCTURE THAT IS EXPECTED WHICH
                   DIFFERS FOR THE TWO POSSIBLE CASES. THIS
                   FILE MUST EXIST FOR INTERFACING WITH STAGS

FRESUR      L      TRUE IF FREE SURFACE EFFECTS ARE TO BE
                   INCLUDED IN THE FLUID MASS MATRIX,
                   OTHERWISE FALSE. THE VARIABLES DEPTH,
                   CXFS, CYFS, AND CZFS ARE USED TO DEFINE
                   THE LOCATION AND ORIENTATION OF THE FREE
                   SURFACE. THIS OPTION CANNOT BE USED
                   SIMULTANEOUSLY WITH HAFMOD = .TRUE.

RENUMB      L      TRUE IF SOME RENUMBERING OF THE STRUCTURAL
                   NODE NUMBERS MUST BE CARRIED OUT AFTER THE
                   FLUID-STRUCTURE TRANSFORMATION DATA HAS
                   BEEN GENERATED, OTHERWISE FALSE. THIS
                   OPTION IS IMPORTANT IF THE USE OF A
                   PARTICULAR STRUCTURAL NODE NUMBER IS
                   CONVENIENT TO DEFINE THE FLUID MESH BUT,
                   INSTEAD, A NEARBY STRUCTURAL NODE SHOULD
                   BE USED FOR FORCE APPLICATION DURING THE
                   UNDERWATER SHOCK ANALYSIS TIME INTEGRATION
                   RUN. THIS CASE IS PARTICULARLY IMPORTANT
                   IF THE TWO POINTS IN QUESTION ARE JOINED
                   BY A RIGID LINK AND THE STUCTURAL POINT
                   ORIGINALLY USED TO DEFINE THE FLUID MESH
                   IS ELIMINATED FROM THE STIFFNESS MATRIX BY
                   A CONSTRAINT EQUATION. WITHOUT THE USE OF
                   THIS OPTION THE APPROPRIATE FORCE WOULD
                   NOT BE APPLIED TO THE EQUATIONS OF MOTION

STOGMT      L      TRUE IF THE FLUID MESH GEOMETRY AND
                   FLUID-STRUCTURE TRANSFORMATION DATA IS TO
                   PUT IN PERMANENT STORAGE, OTHERWISE FALSE

ROTGEO      L      TRUE IF THE FLUID MESH GEOMETRY IS TO BE
                   REFERRED TO A SET OF GLOBAL COORDINATE
                   AXES WHICH IS DIFFERENT FROM THAT OF THE
                   BASIC INPUT DATA FOR ALL SUBSEQUENT USA
                   PROCESSING (SEE GEOANG), OTHERWISE FALSE

ROTQUA      L      TRUE IF THE FLUID MESH GEOMETRY IS TO BE
                   REFERRED TO A SET OF GLOBAL COORDINATE
                   AXES WHICH IS DIFFERENT FROM THAT OF THE
                   BASIC INPUT DATA ONLY FOR COMPUTATION OF
                   THE FLUID MASS MATRIX (SEE QUAANG),
                   OTHERWISE FALSE. THIS OPTION IS TO BE USED
                   IF A QUARTER MODEL IS REQUIRED AND THE
                   INPUT DATA REFERENCE AXES DO NOT COINCIDE
                   WITH THE DEFAULT SYMMETRY AXES. THIS
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		FEATURE CAN ALSO BE USED IN CONJUNCTION WITH THE TWO DIMENSIONAL PLANE STRAIN MODEL AS WELL (SEE *TWODIM*)
FLUNAM	A	NAME OF PERMANENT MASS STORAGE FILE WHICH WILL CONTAIN THE FLUID MASS MATRIX
GEONAM	A	NAME OF PERMANENT MASS STORAGE FILE WHICH WILL CONTAIN THE FLUID MESH GEOMETRY AND FLUID-STRUCTURE TRANSFORMATION DATA
GRDNAM	A	NAME OF PERMANENT MASS STORAGE FILE WHICH CONTAINS THE GLOBAL COORDINATES OF THE STRUCTURAL GRID POINTS
DAANAM	A	NAME OF PERMANENT MASS STORAGE FILE WHICH WILL CONTAIN THE MANIPULATED DAA FORM OF THE FLUID MASS MATRIX
NVEC	I	NUMBER OF FLUID BOUNDARY MODE EIGENVECTORS DESIRED. THESE ARE ORDERED STARTING WITH THE LOWEST ORDER MODES FIRST. IF ALL THE MODES ARE DESIRED THE USER CAN JUST SET NVEC TO 1000 AND THE CODE WILL AUTOMATICALLY REDUCE THIS NUMBER TO THE ORDER OF THE FLUID MASS MATRIX. THIS IS CONVENIENT WHEN THE MODEL CONTAINS SOR ELEMENTS FOR SEVERAL HARMONICS AND/OR BRANCHES AND THE USER DOES NOT WANT TO SPEND TIME COUNTING UP THE TOTAL. THIS IS RECOMMENDED ONLY FOR SMALL OR INTERMEDIATE SIZE PROBLEMS. FOR LARGE PROBLEMS PRINTING OF ONLY THE FIRST 10 EIGENVECTORS IS RECOMMENDED. AS IT IS ONLY THE FIRST FEW ARE GENERALLY USEFUL TO VERIFY SYMMETRIES OR OTHER FEATURES OF THE MODEL. THE FIRST ONE IS ALWAYS A BREATHING TYPE MODE UNLESS THE FLUID MODEL CONSISTS SOLELY OF BEAM TYPE SOR ELEMENTS
NUMZ	I	NUMBER OF FICTITIOUS ELEMENTS TO BE ADDED IN AXIAL DIRECTION WHICH INCREASE THE HALF LENGTH OF THE SURFACE FOR THE SIMULATION OF A TWO DIMENSIONAL PLANE STRAIN FLUID MASS MATRIX. THESE ELEMENTS DO NOT INTRODUCE NEW DEGREES OF FREEDOM
ZLEN	E,F	LENGTH OF FICTITIOUS AXIAL ELEMENTS USED IN THE SIMULATION OF A TWO DIMENSIONAL PLANE STRAIN FLUID MASS MATRIX
CQ	E,F	USED FOR FLUID MESH MODELS WITH PLANES OF SYMMETRY. CQ TAKES ON THE VALUE OF EITHER PLUS OR MINUS ONE TO DENOTE SYMMETRIC OR ANTISYMMETRIC FLOW CONDITIONS IN EACH FLUID REGION INCLUDING THOSE THAT ARE NOT EXPLICITLY CONTAINED IN THE MODEL. FOR A QUARTER MODEL 4 VALUES ARE REQUIRED. ONE

		FOR EACH QUADRANT. ONLY 2 VALUES ARE NECESSARY FOR A HALF MODEL
DEPTH	E,F	MAGNITUDE OF PERPENDICULAR DISTANCE FROM THE ORIGIN OF COORDINATES TO THE PLANE OF A FREE SURFACE OR THE PLANE OF SYMMETRY FOR A HALF MODEL
CXFS, CYFS, CZFS	E,F	DIRECTION COSINES OF A UNIT VECTOR NORMAL TO THE PLANE OF A FREE SURFACE OR THE PLANE OF SYMMETRY FOR A HALF MODEL AND POINTING OUT OF THE FLUID REGION EXPLICITLY CONTAINED IN THE MODEL. THEY MUST BE RELATIVE TO THE GLOBAL CARTESIAN COORDINATES OF THE FLUID MESH. IF ANY COORDINATE ROTATIONS ARE APPLIED TO THE FLUID MESH GEOMETRY (SEE ROTGEO AND ROTQUA) THESE QUANTITIES WILL ALSO BE TRANSFORMED
PATM	E,F	AMBIENT ATMOSPHERIC PRESSURE THAT IS USED ULTIMATELY TO TEST FOR BULK CAVITATION IN THE UNDERWATER SHOCK ANALYSIS
GRAVAC	E,F	ACCELERATION DUE TO GRAVITY
GEOANG	E,F	EULERIAN ANGLES OF ROTATION USED TO DESCRIBE A PERMANENT COORDINATE TRANSFORMATION FOR THE FLUID MESH GEOMETRY. THREE VALUES EXPRESSED IN DEGREES ARE REQUIRED. THE FIRST IS THE ROTATION ABOUT THE ORIGINAL X AXIS, THE SECOND IS THE ROTATION ABOUT THE LINE COINCIDENT WITH THE CURRENT ORIENTATION OF THE ORIGINAL Y AXIS AFTER THE FIRST ROTATION, AND FINALLY THE THIRD IS THE ROTATION ABOUT THE LINE COINCIDENT WITH THE CURRENT ORIENTATION OF THE ORIGINAL Z AXIS AFTER THE FIRST TWO ROTATIONS. ALTHOUGH THIS METHOD MAY BE SOMEWHAT CUMBERSOME FOR ARBITRARY SPATIAL ORIENTATIONS ALMOST ALL CASES OF PRACTICAL INTEREST WILL DEAL ONLY WITH VALUES OF 0, 90, AND/OR 180 DEGREES
QUAANG	E,F	EULERIAN ANGLES OF ROTATION USED TO DESCRIBE A TEMPORARY COORDINATE TRANSFORMATION FOR THE FLUID MESH GEOMETRY (SEE GEOANG ABOVE FOR PRECISE DEFINITION). IF A QUARTER MODEL IS REQUIRED AND THE MESH HAS BEEN GENERATED AUTOMATICALLY FOR A CYLINDRICAL SURFACE BOUNDED BY 0 AND 180 DEGREES THEN THE APPROPRIATE ANGLES TO USE HERE WOULD BE 90, 90, AND 0
NSHIFT	I	A PARAMETER THAT IS ADDED TO THE VALUE OF NLAST (SEE BELOW) IN THE NUMBERING OF

		FLUID ELEMENTS AUTOMATICALLY GENERATED FOR CYLINDRICAL SURFACES. THIS OPTION IS USEFUL IF A FLUID MESH HAS BEEN CONSTRUCTED WITH BOTH GEN ELEMENTS AND CYLINDRICAL SURFACE ELEMENTS AND THEN GEN ELEMENTS ARE REMOVED OR ADDED LATER IN A REMODELING EFFORT. SINCE GEN ELEMENTS APPEAR FIRST IN THE ELEMENT LIST THE USE OF THIS PARAMETER ELIMINATES ANY NEED TO CHANGE THE NUMBERING SCHEME ON DATA CARDS FOR CYLINDRICAL SURFACE ELEMENTS. NSHIFT MAY BE POSITIVE, NEGATIVE, OR ZERO
NSEQ	I	STRUCTURAL GRID POINT NUMBER
NS	I	INDICATOR TO DENOTE TYPE OF COORDINATE SYSTEM GRID POINT DATA IS REFERRED TO. ALLOWABLE VALUES ARE: 0 - GLOBAL CARTESIAN 1 - POLAR CYLINDRICAL, AXIS IN GLOBAL X DIRECTION 2 - POLAR CYLINDRICAL, AXIS IN GLOBAL Y DIRECTION 3 - POLAR CYLINDRICAL, AXIS IN GLOBAL Z DIRECTION
XC,YC,ZC	E,F	CARTESIAN COORDINATES OF STRUCTURAL GRID POINT IF NS = 0. IF NS = 1, 2, OR 3 THESE ARE THE RADIAL, CIRCUMFERENTIAL, AND AXIAL COORDINATES RESPECTIVELY IN A POLAR CYLINDRICAL SYSTEM. THE CIRCUMFERENTIAL ANGLE MUST BE EXPRESSED IN DEGREES AND BE MEASURED FROM THE Y, Z, OR X AXIS RESPECTIVELY ACCORDING TO WHETHER NS IS EQUAL TO 1, 2, OR 3. IF THE POINT IN QUESTION IS INTERIOR TO THE WET SURFACE OR IS NOT USED IN THE DEFINITION OF THE FLUID MESH THE COORDINATES THEMSELVES ARE NOT REQUIRED
NEL	I	GENERAL FLUID ELEMENT INDEX WHICH RUNS FROM 1 TO NGEN IN SEQUENTIAL ORDER
NC	I	NUMBER OF CORNER POINTS OF GENERAL FLUID ELEMENT, CURRENTLY RESTRICTED TO THE VALUES 3 OR 4. SEE FLUID ELEMENT LIBRARY. THE CORNER POINTS WILL USUALLY PARTICIPATE IN THE FLUID-STRUCTURE TRANSFORMATION
NN	I	NUMBER OF ADDITIONAL STRUCTURAL POINTS ASSOCIATED WITH A PARTICULAR GENERAL FLUID ELEMENT, CURRENTLY HAVING PERMISSIBLE VALUES OF 0, 1, 2, 3, AND 5 IF KTRN = 0 (SEE BELOW AND FLUID ELEMENT LIBRARY). IF KTRN IS NOT EQUAL TO ZERO THEN IT MAY HAVE ANY VALUE UP TO 12 FOR RECTANGLES AND 13 FOR TRIANGLES. THESE ADDITIONAL POINTS

		ALWAYS PARTICIPATE IN THE FLUID-STRUCTURE TRANSFORMATION. IT IS EXTREMELY IMPORTANT TO THE UNDERWATER SHOCK ANALYSIS THAT ALL WETTED STRUCTURAL NODES LOCATED WITHIN AND ON THE BORDERS OF THE FLUID ELEMENT BE INCLUDED IN NN EVEN IF THE CASE KTRN NOT EQUAL TO ZERO MUST BE INVOKED
KURV	I	FLUID ELEMENT CURVATURE FLAG. ACCEPTABLE VALUES ARE: 0 - FLAT ELEMENT 1 - CURVED ELEMENT, CODE WILL DETERMINE AVERAGE CURVATURE OF ELEMENT FROM NEIGHBOR POINT LOCATIONS. DO NOT USE THIS OPTION IF NN = 0 2 - CURVED ELEMENT, USER MUST INPUT PRINCIPLE RADII OF CURVATURE. IF EITHER RADIUS IS SET TO 10000 OR GREATER THEN ITS ASSOCIATED CURVATURE WILL BE SET TO ZERO
KTRN	I	SHOULD HAVE THE VALUE OF ZERO UNDER NORMAL CIRCUMSTANCES WHEN THE FLUID-STRUCTURE TRANSFORMATION COEFFICIENTS ARE COMPUTED BY THE CODE. IF KTRN IS NONZERO THEN THESE COEFFICIENTS ARE DETERMINED BY HAND FOR THE ELEMENT IN QUESTION AND MUST BE READ AS INPUT DATA. THIS MUST BE DONE IF THE ELEMENT DOES NOT FIT ANY OF THE STANDARD PATTERNS IN THE FLUID ELEMENT LIBRARY. A DISCUSSION OF HOW TO DO THIS IN AN APPROXIMATE FASHION IS GIVEN BELOW (SEE TRAN)
NODE	I	NODE POINT NUMBERS OF FLUID ELEMENT CORNER POINTS TAKEN IN COUNTER CLOCKWISE DIRECTION. IN GENERAL THE SIDE DEFINED BY THE FIRST TWO CORNER POINTS SHOULD BE ROUGHLY ORIENTED IN THE DIRECTION OF ONE OF THE PRINCIPAL AXES OF THE ELEMENT SO AS TO KEEP THE PRODUCT OF INERTIA OF THE ELEMENT SMALL RELATIVE TO ITS PRINCIPAL MOMENTS OF INERTIA. IF THIS RULE IS NOT FOLLOWED IT IS POSSIBLE THAT THE FLUID - STRUCTURE TRANSFORMATION ARRAY FOR THE ELEMENT WILL BE ILL CONDITIONED. ASSIGN A NEGATIVE VALUE TO ANY NODE NUMBER THAT IS NOT PART OF THE STRUCTURAL FINITE ELEMENT MODEL SO THEY WILL NOT PARTICIPATE IN THE FLUID - STRUCTURE TRANSFORMATION. AT PRESENT SUCH POINTS CAN ONLY BE USED IN CONJUNCTION WITH 6 - NODE QUADRILATERALS. SEE FLUID ELEMENT LIBRARY
ITEM	I	NODE POINT NUMBERS OF FLUID ELEMENT NEIGHBOR POINTS AGAIN TAKEN IN COUNTER CLOCKWISE ORDER STARTING FROM FIRST CORNER

		POINT. ANY INTERIOR POINTS MUST APPEAR LAST. SEE FLUID ELEMENT LIBRARY
RAD1	E,F	RADIUS OF CURVATURE OF FLUID ELEMENT IN DIRECTION FROM FIRST CORNER POINT TO SECOND CORNER POINT
RAD2	E,F	RADIUS OF CURVATURE OF FLUID ELEMENT IN DIRECTION PERPENDICULAR TO SIDE JOINING FIRST CORNER POINT AND SECOND CORNER POINT
ECCEN	E,F	PROVIDES A MEANS OF SHIFTING THE FLUID CONTROL POINT OUT OF THE PLANE OF THE STRUCTURAL NODE POINTS TO ALLOW FOR A FINITE PLATE OR SHELL THICKNESS. GENERALLY USED TO DEFINE SEPARATE FLUID ELEMENTS ON OPPOSITE SIDES OF A SURFACE. A POSITIVE VALUE INDICATES AN ECCENTRICITY IN THE DIRECTION OF THE OUTWARD UNIT NORMAL VECTOR. THIS OPTION MAY BE USED ONLY WITH KURV EQUAL TO 2 AT THIS TIME. WHEN DEFINING TWO FLUID ELEMENTS ON OPPOSITE SIDES OF A SURFACE THE FIRST AND SECOND NODE NUMBERS INPUT FOR ONE ELEMENT (SEE NODE) SHOULD BE THE SECOND AND FIRST NODE NUMBERS RESPECTIVELY FOR THE OTHER ELEMENT. IN THIS WAY THE LOCAL COORDINATE SYSTEM FOR EACH ELEMENT IS REFERRED TO THE SAME BASELINE THUS PRESERVING A DESIRED SYMMETRY IN THE CALCULATIONS
TRAN	E,F	HAND DETERMINED COEFFICIENTS OF THE FLUID-STRUCTURE TRANSFOMATION ARRAY THAT MUST BE READ AS INPUT DATA. THE MOST CONVENIENT WAY OF GENERATING THESE COEFFICIENTS IS TO FIRST BREAK THE ELEMENT INTO SUB-ELEMENTS SUCH AS TRIANGLES OR RECTANGLES SUCH THAT EVERY STRUCTURAL NODE IS A CORNER POINT FOR ONE OR MORE SUB-ELEMENTS.THE WEIGHTING COEFFICIENTS FOR TRIANGLES AND RECTANGLES ARE ONE-THIRD AND ONE-FOURTH RESPECTIVELY AND REPRESENT THE PERCENTAGE OF FLUID PRESSURE FORCE ON THE SUB-ELEMENT THAT IS TRANSMITTED TO ANY PARTICULAR CORNER POINT. THE FLUID-STRUCTURE TRANSFORMATION COEFFICIENT FOR ANY PARTICULAR STRUCTURAL NODE IS THEN EXPRESSED AS A SUM OVER THE SUB-ELEMENTS THAT COUPLE WITH THE NODE IN QUESTION. THE CONTRIBUTION TO THIS SUM FROM EACH SUB-ELEMENT IS JUST THE WEIGHTING COEFFICIENT OF THE SUB-ELEMENT TIMES THE AREA OF THE SUB-ELEMENT DIVIDED BY THE TOTAL AREA OF THE ELEMENT. NOTE THAT THE SUM OF THE FLUID-STRUCTURE TRANSFORMATION COEFFICIENTS FOR ANY FLUID ELEMENT MUST TOTAL UNITY. IF THE FLUID ELEMENT HAS A NON-STRUCTURAL POINT AS A CORNER FOLLOW

THE ABOVE PROCESS ANYWAY AND THEN ADD THE RESULTING COEFFICIENT FOR THE POINT IN QUESTION TO THAT FOR ITS NEAREST STRUCTURAL NODE. IF NECESSARY THE CONTRIBUTION COULD EVEN BE DIVIDED BETWEEN TWO OR MORE NODE POINTS. ONCE COMPUTED, THE ORDER OF INPUT TO THE CODE MUST AGREE WITH THE ORDER TAKEN FIRST BY THE CORNER POINT NODE NUMBERS (SEE NODE) AND THEN BY THE NEIGHBOR POINT NODE NUMBERS (SEE ITEM) CONSECUTIVELY

NTCY I NUMBER OF STRUCTURAL NODE POINTS THAT COUPLE WITH A CURVED RECTANGULAR FLUID ELEMENT WHICH IS TO BE AUTOMATICALLY FORMED FOR AN AXIAL SEGMENT OF A RIGHT CIRCULAR CYLINDRICAL SURFACE. AVAILABLE OPTIONS ARE:

2 - STRUCTURAL NODES WILL BE ON MIDPOINT OF CURVED SIDES
4 - STRUCTURAL NODES WILL BE AT CORNERS
6 - FLUID ELEMENT WILL OVERLAP TWO (2) STRUCTURAL ELEMENTS. VARIABLE KFUN BELOW ALSO REQUIRED IN THIS CASE
9 - FLUID ELEMENT WILL OVERLAP FOUR (4) STRUCTURAL ELEMENTS, TWO IN THE AXIAL DIRECTION AND TWO IN THE CIRCUMFERENTIAL DIRECTION

KFUN I DESCRIBES MANNER IN WHICH A SIX NODE RECTANGULAR FLUID ELEMENT OVERLAYS TWO RECTANGULAR STRUCTURAL ELEMENTS. PERMISSIBLE VALUES ARE:

1 - CONFIGURATION CONSISTS OF TWO STRUCTURAL ELEMENTS IN AXIAL DIRECTION
2 - CONFIGURATION CONSISTS OF TWO STRUCTURAL ELEMENTS IN CIRCUMFERENTIAL DIRECTION

KROT I IF KROT = 0 THE Z DIRECTION WILL BE TAKEN AS THE AXIS FOR AUTOMATICALLY GENERATED ELEMENTS OVER A CYLINDRICAL SURFACE. IF KROT IS NOT EQUAL TO ZERO A ROTATION OF AXES WILL BE PERFORMED (SEE CYLANG)

KARC I A VALUE OF ZERO USED UNDER NORMAL CONDITIONS INDICATES THAT THE AREA ASSOCIATED WITH AUTOMATICALLY GENERATED CYLINDRICAL SURFACE ELEMENTS IS TO BE CALCULATED USING THE CHORD WHICH AGREES WITH WHAT MOST STRUCTURAL FINITE ELEMENT CODES ASSUME. A VALUE OTHER THAN ZERO WILL SPECIFY THAT THE ARC LENGTH IS TO BE USED INSTEAD. THE DIFFERENCE BETWEEN THESE TWO CASES IS GENERALLY VERY SMALL FOR ANY

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                                    REASONABLE CIRCUMFERENTIAL SPACING OF THE
                                    ELEMENTS. THE LATTER CAN GENERATE A
                                    SLIGHTLY MORE ACCURATE FLUID MASS MATRIX
                                    HOWEVER THE FORMER CAN GIVE A SLIGHTLY
                                    BETTER STRUCTURAL RESPONSE CALCULATION

         NCRC           I           NUMBER OF CIRCUMFERENTIAL GENERAL ELEMENTS
                                    TO BE FORMED AUTOMATICALLY FOR AN AXIAL
                                    SEGMENT OF A RIGHT CIRCULAR CYLINDRICAL
                                    SURFACE

         NLAST          I           NUMBER OF LAST FLUID ELEMENT IN SURFACE
                                    MESH WHICH PRECEEDES THE INPUT FOR THIS
                                    AXIAL SEGMENT. NLAST CAN HAVE THE VALUE OF
                                    ZERO IF REQUIRED

         NSTART         I           NUMBER OF STRUCTURAL GRID OR NODE POINT AT
                                    BOTTOM LEFT HAND CORNER OF THE FIRST OF
                                    THIS SET OF CIRCUMFERENTIAL GENERAL FLUID
                                    ELEMENTS. IF NTCY = 2 THIS IS THE NODE AT
                                    THE MIDPOINT OF THE LEFT HAND SIDE

         NDAX1          I           INCREMENT TO BE APPLIED TO NSTART IN
                                    DESIGNATING THE NUMBER OF THE
                                    CORRESPONDING STRUCTURAL NODE AT THE FIRST
                                    ROW OF CIRCUMFERENTIAL STRUCTURAL NODES TO
                                    THE RIGHT OF NSTART IN THE AXIAL DIRECTION

         NDCR           I           INCREMENT TO BE APPLIED TO NSTART IN
                                    DESIGNATING THE NUMBER OF THE
                                    CORRESPONDING STRUCTURAL NODE AT THE FIRST
                                    ROW OF AXIAL STRUCTURAL NODES ABOVE NSTART
                                    IN THE CIRCUMFERENTIAL DIRECTION. FOR THE
                                    CASE NTCY = 6 WITH KFUN = 2, OR NTCY = 9
                                    IT IS ASSUMED THAT NDCR IS THE SAME FOR
                                    EACH CIRCUMFERENTIAL INCREMENT

         NDAX2          I           INCREMENT TO BE APPLIED TO NSTART + NDAX1
                                    IN DESIGNATING THE NUMBER OF THE
                                    CORRESPONDING STRUCTURAL NODE AT THE
                                    SECOND ROW OF CIRCUMFERENTIAL STRUCTURAL
                                    NODES TO THE RIGHT OF NSTART IN THE AXIAL
                                    DIRECTION. THIS CASE IS CHARACTERIZED BY
                                    NTCY = 6 WITH KFUN = 1, OR NTCY = 9.
                                    OTHERWISE NDAX2 CAN BE SET TO ZERO

         RAD            E,F         RADIUS OF  CIRCULAR CYLINDRICAL SURFACE

         AXL1           E,F         AXIAL COORDINATE OF THE FIRST ROW OF
                                    STRUCTURAL NODES IN THE CIRCUMFERENTIAL
                                    DIRECTION THAT COUPLE WITH A PARTICULAR
                                    SET OF CYLINDRICAL SURFACE GENERAL
                                    ELEMENTS. THIS ROW WILL FORM THE LEFT
                                    AXIAL BOUNDARY OF THE SET OF FLUID
                                    ELEMENTS

         AXL2           E,F         AXIAL COORDINATE OF THE SECOND ROW OF
                                    STRUCTURAL NODES IN THE CIRCUMFERENTIAL
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                              DIRECTION THAT COUPLE WITH A PARTICULAR
                              SET OF CYLINDRICAL SURFACE GENERAL
                              ELEMENTS. THIS ROW WILL FORM THE RIGHT
                              AXIAL BOUNDARY OF THE SET OF FLUID
                              ELEMENTS IF NTCY = 2, NTCY = 4, OR
                              NTCY = 6 WITH KFUN = 2. IF NTCY = 6 WITH
                              KFUN = 1, OR NTCY = 9 THIS ROW WILL LIE
                              WITHIN THE INTERIOR OF THE FLUID ELEMENT
                              AND THE STRUCTURAL NODES AT THIS LOCATION
                              WILL BE CONSIDERED AS NEIGHBOR POINTS IN
                              THE FLUID STRUCTURE TRANSFORMATION ARRAY

        THETS         E,F     ANGLE IN DEGREES THAT SPECIFIES THE
                              STARTING BOUNDARY FOR A SET OF GENERAL
                              ELEMENTS AROUND THE PARTIAL CIRCUMFERENCE
                              OF A RIGHT CIRCULAR CYLINDRICAL SURFACE.
                              THE X AXIS IS DEFINED AS ZERO AND THETS
                              CAN BE NEGATIVE IF DESIRED. THIS OPTION IS
                              IMPORTANT AS A DISCONTINUITY OF 360
                              DEGREES IN THE ANGULAR FUNCTION AT THE X
                              AXIS IS NOT PERMITTED

        THETF         E,F     ANGLE IN DEGREES THAT SPECIFIES THE
                              FINISHING BOUNDARY FOR A SET OF GENERAL
                              ELEMENTS AROUND THE PARTIAL CIRCUMFERENCE
                              OF A RIGHT CIRCULAR CYLINDRICAL SURFACE.
                              THE X AXIS IS DEFINED AS ZERO AND THETF
                              MUST BE POSITIVE. HOWEVER IT CAN BE EITHER
                              LARGER OR SMALLER THAN THE MAGNITUDE OF
                              THETS

        AXL3          E,F     AXIAL COORDINATE OF THE THIRD ROW OF
                              STRUCTURAL NODES IN THE CIRCUMFERENTIAL
                              DIRECTION THAT COUPLE WITH A PARTICULAR
                              SET OF CYLINDRICAL SURFACE GENERAL
                              ELEMENTS. IF AXL3 IS NON-ZERO THEN IT MUST
                              BE ALGEBRAICALLY GREATER THAN AXL2 AND
                              THIS ROW WILL THEN FORM THE RIGHT AXIAL
                              BOUNDARY OF THE SET OF FLUID ELEMENTS.
                              THIS CASE IS CHARACTERIZED BY NTCY = 6
                              WITH KFUN = 1, OR NTCY = 9

        CYLANG        E,F     EULERIAN ANGLES OF ROTATION USED TO ORIENT
                              THE AXIS OF CYLINDRICAL SURFACE GENERAL
                              ELEMENTS (SEE GEOANG FOR GENERAL
                              DEFINITION). IN THE FOLLOWING SPECIAL
                              CASES OF IMPORTANCE THE DESIRED AXIS IS
                              SHOWN IN THE LEFT HAND COLUMN WHILE THE
                              APPROPRIATE ANGLES ARE GIVEN TO THE RIGHT:

                                X - 90, 180, 90     OR     0, +/-90, 0
                                Y - 0, 90, 90       OR     +/-90, 0, 0
                                Z - NO INPUT, SET KROT = 0

                              THIS OPTION IS NECESSARY WHEN USING STAGS
                              AS THE STRUCTURAL PROCESSOR IN ITS DEFAULT
                              MODE IN WHICH CASE IT USES THE X DIRECTION
                              AS THE CYLINDER AXIS
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N1	I	GRID POINT NUMBER OF STRUCTURAL NODE THAT DEFINES THE BEGINNING OF A SURFACE OF REVOLUTION BRANCH OR SEGMENT
N2	I	GRID POINT NUMBER OF STRUCTURAL NODE THAT DEFINES THE END OF A SURFACE OF REVOLUTION BRANCH OR SEGMENT
R1	E,F	RADIUS TO WET SURFACE FROM AXIS OF SURFACE OF REVOLUTION ELEMENT AT STRUCTURAL GRID POINT DEFINING THE START OF A SOR BRANCH OR SEGMENT
R2	E,F	RADIUS TO WET SURFACE FROM AXIS OF SURFACE OF REVOLUTION ELEMENT AT STRUCTURAL GRID POINT DEFINING THE END OF A SOR BRANCH OR SEGMENT
NSET	I	NUMBER OF DATA CARDS REQUIRED TO DEFINE SURFACE OF REVOLUTION FLUID ELEMENTS ALONG THE LENGTH OF A PARTICULAR SOR BRANCH OR AXIS. IF NSET = 1 IT IS ASSUMED THAT THE PHYSICAL CONFIGURATION OF THE SOR BRANCH IS AS DESCRIBED BELOW UNDER ISEG
N3	I	GRID POINT NUMBER OF STRUCTURAL NODE THAT DEFINES THE AXIS OF THE SURFACE OF REVOLUTION BRANCH IN CONJUNCTION WITH N1 IF N2 = N1. THIS CASE CORRESPONDS TO A DISC
ISEG	I	NUMBER OF SURFACE OF REVOLUTION ELEMENTS THAT CAN BE DEFINED BETWEEN TWO AXIAL STATIONS SUCH THAT THE RADIUS OF THE SURFACE VARIES LINEARLY ALONG THE LENGTH AND THAT EVERY PAIR OF INTERMEDIATE ADJACENT STRUCTURAL NODE NUMBERS DIFFER BY A COMMON INCREMENTAL VALUE. THIS NEED NOT IMPLY EQUAL AXIAL SPACING OF THE SOR ELEMENTS AS THE STRUCTURAL NODES MAY NOT NECESSARILY BE EQUALLY SPACED ALONG THE AXIS
NUMCHG	I	NUMBER OF STRUCTURAL GRID POINTS THAT MUST BE RENUMBERED IN THE FLUID-STRUCTURE TRANSFORMATION DATA
NODOLD	I	STRUCTURAL GRID POINT NUMBER THAT IS TO BE CHANGED TO NODNEW IN THE FLUID-STRUCTURE TRANSFORMATION DATA
NODNEW	I	NEW STRUCTURAL GRID POINT NUMBER ASSIGNED TO FLUID-STRUCTURE TRANSFORMATION DATA IN PLACE OF NODOLD. THIS GRID POINT MUST ALREADY BE PART OF THE STRUCTURAL NODE GLOBAL COORDINATE DATA INPUT FROM CARDS AND/OR PERMANENT FILE

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              I N P U T     D A T A     C A R D     D E C K

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     ALL INPUT DATA EXCEPT ALPHANUMERIC DATA MUST BE RIGHT JUSTIFIED
     IN EIGHT (8) COLUMN FIELDS WHICH CAN OCCUPY THE ENTIRE CARD.
     ALPHANUMERIC DATA MUST BE LEFT JUSTIFIED IN TWENTY (20) COLUMN
     FIELDS. FILE NAME PLUS QUALIFIER IS CURRENTLY RESTRICTED TO
     EIGHTEEN (18) CHARACTERS FOR UNIVAC OPERATION WHILE NINETEEN (19)
     CHARACTERS MAY BE USED FOR CDC OPERATION

     NOTE THAT THERE IS A DESCRIPTIVE ENTRY IN THE FIRST FIELD OF SOME
     INPUT CARDS AND THAT THE DATA FOR THAT CARD ACTUALLY BEGINS IN THE
     SECOND FIELD. THIS OCCURS IN SUBROUTINES READST, GENELM, CYLGEO
     AND SORINP IN WHICH THE DESCRIPTOR IS GRID, GEN, CYL, AND SOR
     RESPECTIVELY. THIS PRACTICE IS A RESULT OF CHOOSING THE 'GRID'
     CARDS TO BE IDENTICAL TO THE INPUT TO NASTRAN FOR CONVENIENCE IN
     INTERFACING WITH THAT CODE. THE 'GEN', 'CYL' AND 'SOR' CARDS HAVE
     NOTHING TO DO WITH NASTRAN AND THE USAGE OF SUCH LABELS HERE IS
     FOR IDENTIFICATION ONLY

     GENERAL PROBLEM DEFINITION (SUBROUTINE AMINPT):
     -----------------------------------------------

     72 COLUMN ALPHANUMERIC TITLE
     NSTRC    NSTRF    NGEN     NBRA     NCYL

     IF NBRA NOT = 0 INCLUDE THE FOLLOWING THREE CARDS

     NHAS     NHAF     NHAI     NFUN     ITRG
     NSEG(I), I=1,NBRA
     NCIR(I), I=1,NBRA

     RHO      CEE      DAA2
     PRTGMT   PRTTRN   PRTAMF   CALCAM   PRTCOE
     EIGMAF   TWODIM   HAFMOD   QUAMOD
     PCHCDS   NASTAM   STOMAS   STOINV
     FRWTFL   FRWTGE   FRWTGR   FRESUR
     RENUMB   STOGMT   ROTGEO   ROTQUA
     FLUNAM              GEONAM              GRDNAM              DAANAM

     IF EIGMAF = .TRUE. INCLUDE THE FOLLOWING CARD

     NVEC

     IF TWODIM = .TRUE. INCLUDE THE FOLLOWING TWO CARDS

     NUMZ
     ZLEN

     IF QUAMOD = .TRUE. INCLUDE THE FOLLOWING CARD

     CQ(I), I=1,4

     IF HAFMOD = .TRUE. INCLUDE THE FOLLOWING TWO CARDS
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CQ(I), I=1,2
DEPTH   CXFS    CYFS    CZFS

IF FRESUR = .TRUE. INCLUDE THE FOLLOWING TWO CARDS

DEPTH   CXFS    CYFS    CZFS
PATM    GRAVAC

IF ROTGEO = .TRUE. INCLUDE THE FOLLOWING CARD

GEOANG(I), I=1,3

IF ROTQUA = .TRUE. INCLUDE THE FOLLOWING CARD

QUAANG(I), I=1,3

IF NCYL NOT = O READ THE FOLLOWING CARD

NSHIFT

STRUCTURAL NODE COORDINATES (SUBROUTINE READST):
-----------------------------------------------

IF NSTRC NOT = O INCLUDE THE FOLLOWING CARDS

GRID    NSEQ    NS      XC      YC      ZC      )
          .       .       .       .       .     )   TOTAL = NSTRC
          .       .       .       .       .     )

GENERAL ELEMENT DEFINITION (SUBROUTINE GENELM):
----------------------------------------------

IF NGEN NOT = O READ THE FOLLOWING CARDS

GEN     NEL     NC      NN      KURV    KTRN    )
        NODE(I), I=1,NC                         )
        ITEM(I), I=1,NN                         )
                                                )
IF KURV = 2 READ THE FOLLOWING CARD             )   TOTAL NUMBER OF
                                                )
        RAD1    RAD2    ECCEN                   )   SETS = NGEN
                                                )
IF KTRN NOT = O READ THE FOLLOWING CARD         )
                                                )
        TRAN(I), I=1,NC+NN                      )

CYLINDRICAL SURFACE GENERAL ELEMENTS (SUBROUTINE CYLGEO):
---------------------------------------------------------

IF NCYL NOT = O READ THE FOLLOWING CARDS FOR EACH AXIAL SEGMENT

CYL     NTCY    KFUN    KROT    KARC
        NCRC    NLAST   NSTART  NDAX1   NDCR    NDAX2
        RAD     AXL1    AXL2    THETS   THETF   AXL3

IF KROT NOT = O READ THE FOLLOWING CARD
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CYLANG(I), I=1,3

SURFACE-OF-REVOLUTION ELEMENT DEFINITION (SUBROUTINE SORINP):
-------------------------------------------------------------

IF NBRA NOT = 0 READ THE FOLLOWING CARDS FOR EACH SOR BRANCH

SOR      N1       N2       R1       R2       NSET

IF N1 = N2 READ THE FOLLOWING CARD

         N3

IF NSET = 1 OMIT THE FOLLOWING CARD

         N1       N2       R1       R2       ISEG    )
         .        .        .        .        .       )   TOTAL = NSET
         .        .        .        .        .       )

STRUCTURAL NODE RENUMBERING (SUBROUTINE AMGEOM):
------------------------------------------------

IF RENUMB = .TRUE. READ THE FOLLOWING CARDS

         NUMCHG
         NODOLD   NODNEW      )
                              )   TOTAL = NUMCHG
                              )
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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

            F L U I D     E L E M E N T     L I B R A R Y

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

   THE CORNER POINTS OF EACH OF THE ELEMENT TYPES SHOWN BELOW ARE
   ASSUMED TO LIE IN THE SAME PLANE AND THE DIRECTION OF THE UNIT
   NORMAL VECTOR IS TAKEN TO BE POSITIVE AS COMING UP FROM THE PAGE
   AND OUT INTO THE FLUID REGION. THE VIEWER IS THUS PLACED IN THE
   SAME RELATIVE POSITION AS A SCUBA DIVER GAZING AT THE SIDE OF A
   SUNKEN TREASURE SHIP. THE NODE ORDER FOR INPUT MUST ALWAYS BE IN
   THE COUNTERCLOCKWISE DIRECTION AS SHOWN BECAUSE THE RIGHT HAND
   RULE IS USED IN THE CODE TO DETERMINE THE POSITIVE OUTWARD
   DIRECTION. NOTE THAT CORNER POINTS ARE TAKEN FIRST, THEN ANY OTHER
   POINTS WHICH MAY BE INVOLVED IN THE FLUID-STRUCTURE TRANSFORMATION
   FOLLOW. YOU MAY PLAY CONNECT-THE-DOTS WITH YOUR PENCIL TO MAKE THE
   FIGURES MORE LEGIBLE IF YOU WISH

  BASIC FLUID ELEMENT CONFIGURATIONS:                    3

            3                                    4
                                                     GENERAL
               TRIANGLE
                                                  QUADRILATERAL
       1.................2
                                               1....................2
  BASIC FLUID ELEMENT CONFIGURATIONS          4
  WITH ADDITIONAL TRANSFORMATION
  POINTS:                                            6

            4...3                             6-NODE      GENERAL
                                                                      3
           6-NODE                                      QUADRILATERAL
          6
                                           1.........5................2

           GENERAL                               4
                         5
          QUADRILATERAL
                                                          7
       1.....................2
                                                 9-NODE        3

                                            8..........9...........6

                                                       GENERAL

                                                     QUADRILATERAL

                                          1........5....................2
```

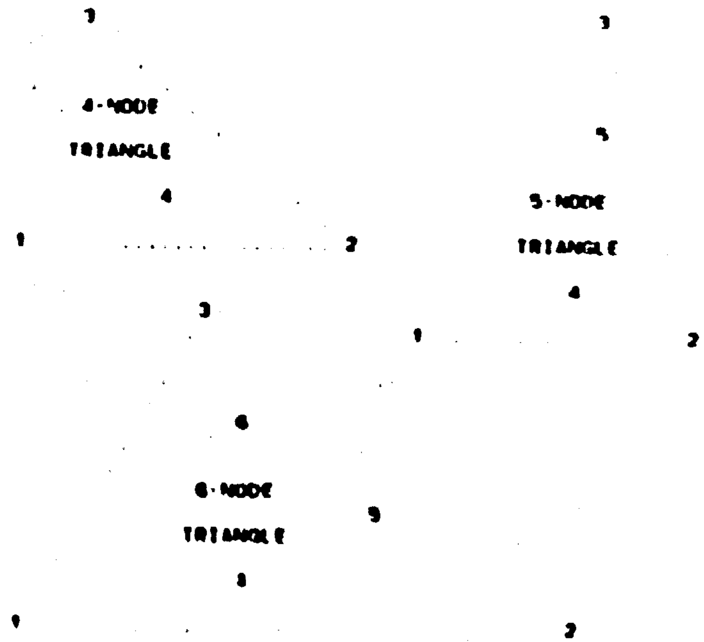

4-NODE
TRIANGLE
5-NODE
TRIANGLE
6-NODE
TRIANGLE

The following discussion is provided as an aid to user understanding of the sample output that is included here.

The first item needing explanation is the block subdivision table. During construction of the mass matrix the code must determine whether a particular fluid DOF pertains to a GEN (includes both GEN and CYL elements) or SOR element. In the latter case, it must also store the branch or axis of the element, its harmonic, and also whether that DOF corresponds to a cosine or sine function. DOF with similar characteristics are naturally kept together in the same block. When the mass matrix is automatically processed in an out of core mode GEN elements are also partitioned into blocks for computational convenience.

The parameters appearing in the block subdivision table are:

ISUB - block number

ITYP - GEN or SOR

IBEG - first row of block

IROW - number of rows in block

IBRA - SOR branch or axis

IHAR - harmonic number

IFUN - COS or SIN

Next, the terms appearing under "Fluid Mesh Geometric Arrays" are defined as:

NCOR	- number of corner points for a particular fluid element
X,Y,Z	- global cartesian coordinates of the fluid element centroidal control point
NX,NY,NZ	- components of the outward unit normal vector for the fluid element
NTRA	- number of structural node points that are coupled to a particular fluid element for the purpose of force application
A00,A20,A11,A02	- area and moments and product of inertia of fluid element. Used internally for construction of the fluid mass matrix and of the fluid-structure transformation coefficients for general elements. For SOR elements, these values are for the sub-elements.
BII,CII	- diagonal terms of B and C matrices used for the construction of fluid mass matrix (see [16])

When SOR elements are included in the fluid mesh the following new terms will appear in the output:

NSOR - number of SOR element

NFLU - DOF in fluid mass matrix

RAD - radius of fluid element control point from axis of revolution

NCIR - number of integration points or sub-elements used in circumferential direction

Local Fluid-Structure Transformation Coefficients appear next. This is a summary that indicates which structural nodes couple with a particular fluid control point and the weighting factor for each. The weighting factors must always sum to unity for any fluid control point.

The generalized areas that follow are simply A00 for GEN elements. For SOR elements with IHAR = 0 they are A00*NCIR; for all other SOR elements they become .5*A00*NCIR.

The eigenvalues and eigenvectors that follow the listing of the added mass matrix correspond to the "Fluid Boundary Mode" problem [16]. For the infinite cylindrical shell problem presented here, the exact eigenvalues should behave as 1/n with corresponding modes cos $n\theta$ and sin $n\theta$. The first eigenvalue listed, 0.11831+04, is an approximation to ∞ for n=0 and it can be seen that the subsequent eigenvalues are relatively well behaved.

If a table labeled "SUMMARY OF I-O ACTIVITY" appears in the output, this indicates that automatic out-of-core processing has taken place. In such a case the "Fluid Boundary Mode" problem is not solved and its diagnostic characteristics are unavailable to the user. If there are any serious errors in the fluid mesh geometry that have remained undetected through the generation of the mass matrix these may show up in the construction of the matrix $\underset{\sim}{D}_{f1}$ [see Eq. (2.6)], i.e., the occurrence of factorization errors for the elements in question.

The following input and output for the infinite circular cylindrical shell problem contain some minor differences due to the fact that the input is appropriate to the standard CDC or UNIVAC USA-STAGS version 3 whereas the output is from the VAX virtual memory machine. The basic reason for this is that the VAX version does not explicitly process the fluid equation system in a multi-block, out-of-core mode in contrast to the CDC and UNIVAC versions. In addition, permanent file naming conventions differ slightly; however it is anticipated that these differences should not prove to be a difficulty for the user.

```
FLUMAS RUN FOR INFINITE CYLINDER SIMULATION
          0       72        0        0       36
         1.       1.       .5
          T        T        T        T        F
          T        T        F        F
          F        F        F        T
          F        F        T        F
          F        T        F        F
                      CYL*GEOM           STG*CYLCOR           CYL*DAAM
         36
        500
       .175
          0
CYL                2        0        0        0
                  36        0        1       36        1
                  1.   -.0875    .0875      -5.     355.
```

```
FLUMAS RUN FOR INFINITE CYLINDER SIMULATION


MAXIMUM FLUID NODES =   156

 SCRATCH ALLOCATION = 50000

FLUID MASS MATRIX BLOCK SUBDIVISION PARAMETERS:

ISUB    ITYP    IBEG    IROW    IBRA    IHAR    IFUN

  1     GEN       1      36

FLUID MASS DENSITY =   0.10000000E+01

FLUID SOUND SPEED  =   0.10000000E+01

USER OPTIONS FOR THIS RUN:

PRTGMT      PRTTRN      PRTAMF      CALCAM      PRTCOE
  T           T           T           T           F

EIGMAF      TWODIM      HAFMOD      QUAMOD
  T           T           F           F

PCMCDS      NASTAM      STOMAS      STOINV
  F           F           T           T

FRWTFL      FRUTGE      FRWTGR      FRESUR
  F           F           T           F

RENUMB      STOGMT      ROTGEO      ROTQUA
  F           T           F           F
+++ OPEN,   1 = DIRTY:CYL.USC          , Acc= SEQUENT, Stat= OLD
+++ Form = UNFORMATTED

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E     +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                            +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc   Next  Limit   Read Written +
+  1 DIRTY:CYL.US  1  1 AX   64      0  10000 100000      0       0 +
+    C                                                       +
+                                                            +
+                  1 Active devices ( 0 full)                +
```

+ 0 To ocs. 0 Writes. 3 Reads 0 Words XFD +
+++

+++ CLOSE. 1

GLOBAL COORDINATES OF STRUCTURAL NODE POINTS:

N	GRID	X	Y	Z
1	1	0.10000000E+01	0.00000000E+00	-0.43711392E-07
2	2	0.98480773E+00	0.17364818E+00	-0.43047315E-07
3	3	0.93969262E+00	0.34202012E+00	-0.41075271E-07
4	4	0.86602539E+00	0.50000000E+00	-0.37855177E-07
5	5	0.76604444E+00	0.64278758E+00	-0.33484870E-07
6	6	0.64278758E+00	0.76604444E+00	-0.28097139E-07
7	7	0.49999997E+00	0.86602545E+00	-0.21855694E-07
8	8	0.34202015E+00	0.93969262E+00	-0.14950176E-07
9	9	0.17364822E+00	0.98480773E+00	-0.75904056E-08
10	10	-0.43711392E-07	0.10000000E+01	0.19106857E-14
11	11	-0.17364819E+00	0.98480773E+00	0.75904033E-08
12	12	-0.34202012E+00	0.93969262E+00	0.14950176E-07
13	13	-0.50000006E+00	0.86602539E+00	0.21855698E-07
14	14	-0.64278764E+00	0.76604444E+00	0.28097142E-07
15	15	-0.76604444E+00	0.64278764E+00	0.33484070E-07
16	16	-0.86602539E+00	0.50000006E+00	0.37855177E-07
17	17	-0.93969262E+00	0.34202021E+00	0.41075271E-07
18	18	-0.98480773E+00	0.17364830E+00	0.43047315E-07
19	19	-0.10000000E+01	-0.87422784E-07	0.43711392E-07
20	20	-0.98480773E+00	-0.17364822E+00	0.43047315E-07
21	21	-0.93969262E+00	-0.34202015E+00	0.41075271E-07
22	22	-0.86602539E+00	-0.49999997E+00	0.37855177E-07
23	23	-0.76604450E+00	-0.64278758E+00	0.33484870E-07
24	24	-0.64278752E+00	-0.76604456E+00	0.28097137E-07
25	25	-0.49999991E+00	-0.86602545E+00	0.21855692E-07
26	26	-0.34202006E+00	-0.93969262E+00	0.14950173E-07
27	27	-0.17364813E+00	-0.98480779E+00	0.75904012E-08
28	28	0.11924080E-07	-0.10000000E+01	-0.52125312E-15
29	29	0.17364815E+00	-0.98480773E+00	-0.75904021E-08
30	30	0.34202009E+00	-0.93969262E+00	-0.14950174E-07
31	31	0.49999991E+00	-0.86602545E+00	-0.21855692E-07
32	32	0.64278752E+00	-0.76604450E+00	-0.28097137E-07
33	33	0.76604432E+00	-0.64278775E+00	-0.33484863E-07
34	34	0.86602533E+00	-0.50000018E+00	-0.37855173E-07
35	35	0.93969256E+00	-0.34202036E+00	-0.41075271E-07
36	36	0.98480773E+00	-0.17364845E+00	-0.43047315E-07
37	37	0.10000000E+01	0.00000000E+00	-0.17500004E+00
38	38	0.98480773E+00	0.17364818E+00	-0.17500004E+00
39	39	0.93969262E+00	0.34202012E+00	-0.17500004E+00
40	40	0.86602539E+00	0.50000000E+00	-0.17500004E+00
41	41	0.76604444E+00	0.64278758E+00	-0.17500003E+00
42	42	0.64278758E+00	0.76604444E+00	-0.17500003E+00

43	43	0.49999997E+00	0.86602545E+00	-0.17500001E+00
44	44	0.34202015E+00	0.93969262E+00	-0.17500001E+00
45	45	0.17364821E+00	0.98480773E+00	-0.17500001E+00
46	46	-0.51360885E-07	0.10000000E+01	-0.17500000E+00
47	47	-0.17364821E+00	0.98480773E+00	-0.17499998E+00
48	48	-0.34202012E+00	0.93969262E+00	-0.17499998E+00
49	49	-0.50000006E+00	0.86602539E+00	-0.17499998E+00
50	50	-0.64278764E+00	0.76604444E+00	-0.17499997E+00
51	51	-0.76604444E+00	0.64278764E+00	-0.17499997E+00
52	52	-0.86602539E+00	0.50000006E+00	-0.17499995E+00
53	53	-0.93969262E+00	0.34202021E+00	-0.17499995E+00
54	54	-0.98480773E+00	0.17364330E+00	-0.17499995E+00
55	55	-0.10000000E+01	-0.87422784E-07	-0.17499995E+00
56	56	-0.98480773E+00	-0.17364822E+00	-0.17499995E+00
57	57	-0.93969262E+00	-0.34202015E+00	-0.17499995E+00
58	58	-0.86602539E+00	-0.49999997E+00	-0.17499995E+00
59	59	-0.76604450E+00	-0.64278758E+00	-0.17499997E+00
60	60	-0.64278752E+00	-0.76604456E+00	-0.17499997E+00
61	61	-0.49999991E+00	-0.86602545E+00	-0.17499998E+00
62	62	-0.34202006E+00	-0.93969262E+00	-0.17499998E+00
63	63	-0.17364815E+00	-0.98480779E+00	-0.17499998E+00
64	64	0.42753863E-08	-0.10000000E+01	-0.17500000E+00
65	65	0.17364813E+00	-0.98480773E+00	-0.17500001E+00
66	66	0.34202009E+00	-0.93969262E+00	-0.17500001E+00
67	67	0.49999991E+00	-0.86602545E+00	-0.17500001E+00
68	68	0.64278752E+00	-0.76604450E+00	-0.17500003E+00
69	69	0.76604432E+00	-0.64278775E+00	-0.17500003E+00
70	70	0.86602533E+00	-0.50000018E+00	-0.17500004E+00
71	71	0.93969256E+00	-0.34202036E+00	-0.17500004E+00
72	72	0.98480773E+00	-0.17364845E+00	-0.17500004E+00

FLUID MESH GEOMETRIC ARRAYS:

N	NCOR	X	Y	Z	NX	NY	NZ
1	4	0.10000000E+01	0.00000000E+00	0.00000000E+00	0.10000000E+01	0.00000000E+00	0.00000000E+00
2	4	0.98480773E+00	0.17364818E+00	0.00000000E+00	0.98480773E+00	0.17364818E+00	0.00000000E+00
3	4	0.93969262E+00	0.34202012E+00	0.00000000E+00	0.93969262E+00	0.34202012E+00	0.00000000E+00
4	4	0.86602539E+00	0.50000000E+00	0.00000000E+00	0.86602539E+00	0.50000000E+00	0.00000000E+00
5	4	0.76604444E+00	0.64278758E+00	0.00000000E+00	0.76604444E+00	0.64278758E+00	0.00000000E+00
6	4	0.64278758E+00	0.76604444E+00	0.00000000E+00	0.64278758E+00	0.76604444E+00	0.00000000E+00
7	4	0.49999997E+00	0.86602545E+00	0.00000000E+00	0.49999997E+00	0.86602545E+00	0.00000000E+00
8	4	0.34202015E+00	0.93969262E+00	0.00000000E+00	0.34202015E+00	0.93969262E+00	0.00000000E+00
9	4	0.17364822E+00	0.98480773E+00	0.00000000E+00	0.17364822E+00	0.98480773E+00	0.00000000E+00
10	4	0.75669959E-07	0.10000000E+01	0.00000000E+00	0.75669959E-07	0.10000000E+01	0.00000000E+00
11	4	-0.17364819E+00	0.98480773E+00	0.00000000E+00	-0.17364819E+00	0.98480773E+00	0.00000000E+00
12	4	-0.34202012E+00	0.93969262E+00	0.00000000E+00	-0.34202012E+00	0.93969262E+00	0.00000000E+00
13	4	-0.50000006E+00	0.86602539E+00	0.00000000E+00	-0.50000006E+00	0.86602539E+00	0.00000000E+00
14	4	-0.64278764E+00	0.76604444E+00	0.00000000E+00	-0.64278764E+00	0.76604444E+00	0.00000000E+00
15	4	-0.76604444E+00	0.64278764E+00	0.00000000E+00	-0.76604444E+00	0.64278764E+00	0.00000000E+00
16	4	-0.86602539E+00	0.50000006E+00	0.00000000E+00	-0.86602539E+00	0.50000006E+00	0.00000000E+00

17	4	-0.93969262E+00	0.34202021E+00	0.00000000E+00	-0.93969262E+00	0.34202021E+00	0.00000000E+00
18	4	-0.98480773E+00	0.17364830E+00	0.00000000E+00	-0.98480773E+00	0.17364830E+00	0.00000000E+00
19	4	-0.10000000E+01	0.15087426E-06	0.00000000E+00	-0.10000000E+01	0.15087426E-06	0.00000000E+00
20	4	-0.98480779E+00	-0.17364800E+00	0.00000000E+00	-0.98480779E+00	-0.17364800E+00	0.00000000E+00
21	4	-0.93969262E+00	-0.34202015E+00	0.00000000E+00	-0.93969262E+00	-0.34202015E+00	0.00000000E+00
22	4	-0.86602539E+00	-0.49999997E+00	0.00000000E+00	-0.86602539E+00	-0.49999997E+00	0.00000000E+00
23	4	-0.76604450E+00	-0.64278758E+00	0.00000000E+00	-0.76604450E+00	-0.64278758E+00	0.00000000E+00
24	4	-0.64278787E+00	-0.76604426E+00	0.00000000E+00	-0.64278787E+00	-0.76604426E+00	0.00000000E+00
25	4	-0.49999991E+00	-0.86602545E+00	0.00000000E+00	-0.49999991E+00	-0.86602545E+00	0.00000000E+00
26	4	-0.34202006E+00	-0.93969262E+00	0.00000000E+00	-0.34202006E+00	-0.93969262E+00	0.00000000E+00
27	4	-0.17364813E+00	-0.98480779E+00	0.00000000E+00	-0.17364813E+00	-0.98480779E+00	0.00000000E+00
28	4	0.11924880E-07	-0.10000000E+01	0.00000000E+00	0.11924880E-07	-0.10000000E+01	0.00000000E+00
29	4	0.17364815E+00	-0.98480773E+00	0.00000000E+00	0.17364815E+00	-0.98480773E+00	0.00000000E+00
30	4	0.34202009E+00	-0.93969262E+00	0.00000000E+00	0.34202009E+00	-0.93969262E+00	0.00000000E+00
31	4	0.49999991E+00	-0.86602545E+00	0.00000000E+00	0.49999991E+00	-0.86602545E+00	0.00000000E+00
32	4	0.64278752E+00	-0.76604450E+00	0.00000000E+00	0.64278752E+00	-0.76604450E+00	0.00000000E+00
33	4	0.76604432E+00	-0.64278775E+00	0.00000000E+00	0.76604432E+00	-0.64278775E+00	0.00000000E+00
34	4	0.86602533E+00	-0.50000018E+00	0.00000000E+00	0.86602533E+00	-0.50000018E+00	0.00000000E+00
35	4	0.93969256E+00	-0.34202036E+00	0.00000000E+00	0.93969256E+00	-0.34202036E+00	0.00000000E+00
36	4	0.98480773E+00	-0.17364845E+00	0.00000000E+00	0.98480773E+00	-0.17364845E+00	0.00000000E+00

N	NTRA	A00	A20	A11	A02	BII	CII
1	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
2	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
3	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
4	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
5	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
6	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
7	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
8	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
9	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
10	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
11	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
12	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
13	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
14	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
15	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
16	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
17	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
18	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
19	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
20	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
21	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
22	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
23	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
24	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
25	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
26	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01
27	2	0.30504508E-01	0.77238677E-04	-0.13500312E-12	0.77850054E-04	0.61574590E+00	0.64371219E+01

```
28       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
29       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
30       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
31  [illegible]  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
32       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
33       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
34       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
35       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01
36       2  0.30504508E-01  0.77238677E-04 -0.13500312E-12  0.77850054E-04  0.61574590E+00  0.64371219E+01

LOCAL FLUID-STRUCTURE TRANSFORMATION COEFFICIENTS:

NFLU        NSTR

  1          1           37
      0.50000E+00 0.50000E+00
  2          2           38
      0.50000E+00 0.50000E+00
  3          3           39
      0.50000E+00 0.50000E+00
  4          4           40
      0.50000E+00 0.50000E+00
  5          5           41
      0.50000E+00 0.50000E+00
  6          6           42
      0.50000E+00 0.50000E+00
  7          7           43
      0.50000E+00 0.50000E+00
  8          8           44
      0.50000E+00 0.50000E+00
  9          9           45
      0.50000E+00 0.50000E+00
 10         10           46
      0.50000E+00 0.50000E+00
 11         11           47
      0.50000E+00 0.50000E+00
 12         12           48
      0.50000E+00 0.50000E+00
 13         13           49
      0.50000E+00 0.50000E+00
 14         14           50
      0.50000E+00 0.50000E+00
 15         15           51
      0.50000E+00 0.50000E+00
 16         16           52
      0.50000E+00 0.50000E+00
 17         17           53
      0.50000E+00 0.50000E+00
 18         18           54
      0.50000E+00 0.50000E+00
 19         19           55
```

```
           0.50000E+00 0.50000E+00
    20          20          56
           0.50000E+00 0.50000E+00
    21          21          57
           0.50000E+00 0.50000E+00
    22          22          58
           0.50000E+00 0.50000E+00
    23          23          59
           0.50000E+00 0.50000E+00
    24          24          60
           0.50000E+00 0.50000E+00
    25          25          61
           0.50000E+00 0.50000E+00
    26          26          62
           0.50000E+00 0.50000E+00
    27          27          63
           0.50000E+00 0.50000E+00
    28          28          64
           0.50000E+00 0.50000E+00
    29          29          65
           0.50000E+00 0.50000E+00
    30          30          66
           0.50000E+00 0.50000E+00
    31          31          67
           0.50000E+00 0.50000E+00
    32          32          68
           0.50000E+00 0.50000E+00
    33          33          69
           0.50000E+00 0.50000E+00
    34          34          70
           0.50000E+00 0.50000E+00
    35          35          71
           0.50000E+00 0.50000E+00
    36          36          72
           0.50000E+00 0.50000E+00
+++  OPEN,   2 = DIRTY:CYL.GEO           , Acc= DIRECT , Stat= NEW

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E                +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                       +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc   Next  Limit      Read Written +
+  2 DIRTY:CYL.GE  2  1 UPR  64     19     19 100000        0     763 +
+    0                                                                  +
+                                                                       +
+                     1 Active devices ( 0 full)                        +
+     0 Tp ops,    13 Writes,     0 Reads          763 Words XFD       +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE,  2
```

GENERALIZED FLUID AREAS:

1	2	3	4	5	6	7	8	9	10
0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01
11	12	13	14	15	16	17	18	19	20
0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01
21	22	23	24	25	26	27	28	29	30
0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01
31	32	33	34	35	36				
0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01	0.30505E-01				

ADDED MASS MATRIX IN FLUID COORDINATES:

	1	2	3	4	5	6	7	8	9	10
1	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01
2	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01
3	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01
4	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01
5	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01
6	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01
7	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01
8	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01
9	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01
10	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01
11	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01
12	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01
13	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01
14	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01
15	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01
16	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01
17	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01
18	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01
19	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01
20	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01
21	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01
22	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01
23	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01
24	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01
25	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01
26	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
27	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
28	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01
29	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01
30	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01
31	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01
32	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01
33	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01
34	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01
35	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01
36	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01
	11	12	13	14	15	16	17	18	19	20

1	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
2	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01
3	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01
4	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01
5	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01
6	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01
7	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01
8	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01
9	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01
10	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01
11	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01
12	0.10055E+01	[illegible]	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01
13	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01
14	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01
15	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01
16	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01
17	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01
18	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01
19	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01
20	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01
21	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01
22	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01
23	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01
24	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01
25	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01
26	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01
27	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01
28	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01
29	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01
30	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01
31	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01
32	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01
33	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01
34	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01
35	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01
36	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01

	21	22	23	24	25	26	27	28	29	30
1	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01
2	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01
3	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01
4	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01
5	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01
6	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01
7	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01
8	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01
9	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01
10	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
11	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
12	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01
13	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01
14	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01

15	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01
16	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01
17	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01
18	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01
19	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01
20	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01
21	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01
22	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01
23	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01
24	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01
25	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01	0.10028E+01
26	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01	0.10031E+01
27	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01	0.10036E+01
28	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01	0.10043E+01
29	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01	0.10055E+01
30	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01	0.10083E+01
31	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01
32	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01
33	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01
34	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01
35	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01
36	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01

	31	32	33	34	35	36
1	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01	0.10055E+01
2	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01	0.10043E+01
3	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01	0.10036E+01
4	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01	0.10031E+01
5	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01	0.10028E+01
6	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01	0.10025E+01
7	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01	0.10022E+01
8	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01	0.10020E+01
9	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01	0.10019E+01
10	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10018E+01
11	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10016E+01
12	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01
13	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01
14	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01
15	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01
16	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
17	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01	0.10013E+01
18	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01	0.10013E+01
19	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01	0.10013E+01
20	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01	0.10013E+01
21	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01	0.10014E+01
22	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01	0.10014E+01
23	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01	0.10015E+01
24	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01	0.10015E+01
25	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01	0.10016E+01
26	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01	0.10018E+01
27	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01	0.10019E+01
28	0.10036E+01	0.10031E+01	0.10028E+01	0.10025E+01	0.10022E+01	0.10020E+01

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 29    0.10043E+01 0.10036E+01 0.10031E+01 0.10028E+01 0.10025E+01 0.10022E+01
 30    0.10055E+01 0.10043E+01 0.10036E+01 0.10031E+01 0.10028E+01 0.10025E+01
 31    0.10083E+01 0.10055E+01 0.10043E+01 0.10036E+01 0.10031E+01 0.10028E+01
 32    0.10055E+01 0.10083E+01 0.10055E+01 0.10043E+01 0.10036E+01 0.10031E+01
 33    0.10043E+01 0.10055E+01 0.10083E+01 0.10055E+01 0.10043E+01 0.10036E+01
 34    0.10076E+01 0.10043E+01 0.10055E+01 0.10083E+01 0.10055E+01 0.10043E+01
 35    0.10031E+01 0.10036E+01 0.10043E+01 0.10055E+01 0.10083E+01 0.10055E+01
 36    0.10028E+01 0.10031E+01 0.10036E+01 0.10043E+01 0.10055E+01 0.10083E+01
+++  OPEN,   3 = DIRTY:CYL.FLU           , Acc= DIRECT , Stat= NEW

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E            +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                    +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc    Next  Limit      Read Written +
+  3 DIRTY:CYL.FL  3  1 UPR  64     21      21 100000        0    1296 +
+    U                                                               +
+                                                                    +
+                 1 Active devices ( 0 full)                         +
+    0 Tp ops,    14 Writes,     0 Reads        2059 Words XFD       +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE,  3
+++  OPEN.   4 = FOR004                  , Acc= DIRECT , Stat= SCRATCH

 EIGENVALUES:

           1           2           3           4           5           6           7           8           9          10
    0.11831E+04 0.99737E+00 0.99736E+00 0.49753E+00 0.49753E+00 0.33038E+00 0.33037E+00 0.24644E+00 0.24643E+00 0.19591E+00
          11          12          13          14          15          16          17          18          19          20
    0.19590E+00 0.16224E+00 0.16223E+00 0.13830E+00 0.13827E+00 0.12052E+00 0.12051E+00 0.10690E+00 0.10688E+00 0.96230E-01
          21          22          23          24          25          26          27          28          29          30
    0.96223E-01 0.87805E-01 0.87793E-01 0.81142E-01 0.81134E-01 0.75892E-01 0.75868E-01 0.71864E-01 0.71843E-01 0.68892E-01
          31          32          33          34          35          36
    0.68883E-01 0.66801E-01 0.66785E-01 0.65605E-01 0.65589E-01 0.65225E-01

 EIGENVECTORS:

           1           2           3           4           5           6           7           8           9          10
  1  -0.95426E+00-0.67723E+00 0.11642E+01 0.10288E+01 0.62627E+00 0.29220E+00 0.13150E+01-0.10819E+01 0.77303E+00 0.84137E+00
  2  -0.95426E+00-0.46437E+00 0.12648E+01 0.66617E+00 0.99724E+00 0.91256E+00 0.98618E+00-0.31021E+00 0.13025E+01-0.26721E+00
  3  -0.95426E+00-0.23719E+00 0.13274E+01 0.22684E+00 0.12482E+01 0.12871E+01 0.39429E+00 0.60653E+00 0.12237E+01-0.11853E+01
  4  -0.95426E+00-0.28747E-02 0.13495E+01-0.24186E+00 0.13434E+01 0.13173E+01-0.30374E+00 0.12395E+01 0.57173E+00-0.12563E+01
  5  -0.95426E+00 0.23151E+00 0.13306E+01-0.69125E+00 0.12861E+01 0.99469E+00-0.92029E+00 0.12926E+01-0.34747E+00-0.42988E+00
  6  -0.95426E+00 0.45887E+00 0.12713E+01-0.10386E+01 0.10686E+01 0.40545E+00-0.12904E+01 0.74076E+00-0.11044E+01 0.70372E+00
  7  -0.95426E+00 0.67230E+00 0.11732E+01-0.12708E+01 0.72207E+00-0.29261E+00-0.13150E+01-0.15759E+00-0.13450E+01 0.13347E+01
  8  -0.95426E+00 0.86526E+00 0.10396E+01-0.13495E+01 0.28866E+00-0.91193E+00-0.98679E+00-0.98239E+00-0.95556E+00 0.10118E+01
  9  -0.95426E+00 0.10320E+01 0.87440E+00-0.12655E+01-0.17968E+00-0.12871E+01-0.39433E+00-0.13473E+01-0.11920E+00-0.33744E-01
 10  -0.95426E+00 0.11673E+01 0.68263E+00-0.10289E+01-0.62630E+00-0.13173E+01 0.30380E+00-0.10820E+01 0.77308E+00-0.10552E+01
 11  -0.95426E+00 0.12672E+01 0.47005E+00-0.66821E+00-0.99747E+00-0.99473E+00 0.92039E+00-0.31019E+00 0.13032E+01-0.13228E+01
 12  -0.95426E+00 0.13285E+01 0.24324E+00-0.22690E+00-0.12483E+01-0.40547E+00 0.12905E+01 0.60677E+00 0.12238E+01-0.64535E+00
```

13	-0.95426E+00	0.13495E+01	0.90521E-02	0.24181E+00	-0.13494E+01	0.29250E+00	0.13148E+01	0.12396E+01	0.57185E+00	0.49313E+00
14	-0.95426E+00	0.13295E+01	-0.22534E+00	0.68144E+00	-0.12858E+01	0.91223E+00	0.98701E+00	0.12926E+01	-0.34733E+00	0.12791E+01
15	-0.95426E+00	0.12691E+01	-0.45304E+00	0.10387E+01	-0.10685E+01	0.12871E+01	0.39432E+00	0.74058E+00	-0.11049E+01	0.11515E+01
16	-0.95426E+00	0.11701E+01	-0.66686E+00	0.12708E+01	-0.72206E+00	0.13175E+01	-0.30376E+00	-0.15778E+00	-0.13448E+01	0.20111E+00
17	-0.95426E+00	0.10356E+01	-0.86649E+00	0.13495E+01	-0.28865E+00	0.99454E+00	-0.92069E+00	-0.98251E+00	-0.95587E+00	-0.89267E+00
18	-0.95426E+00	0.86966E+00	-0.10280E+01	0.12655E+01	0.17970E+00	0.40534E+00	-0.12907E+01	-0.13473E+01	-0.11935E+00	-0.13491E+01
19	-0.95426E+00	0.67722E+00	-0.11641E+01	0.10290E+01	0.62640E+00	-0.29233E+00	-0.13148E+01	-0.10818E+01	0.77336E+00	-0.84168E+00
20	-0.95426E+00	0.46425E+00	-0.12650E+01	0.66815E+00	0.99741E+00	-0.91203E+00	-0.98685E+00	-0.31015E+00	0.13034E+01	0.26745E+00
21	-0.95426E+00	0.23718E+00	-0.13275E+01	0.22679E+00	0.12481E+01	-0.12872E+01	-0.39432E+00	0.60668E+00	0.12237E+01	0.11853E+01
22	-0.95426E+00	0.28867E-02	-0.13495E+01	-0.24186E+00	0.13483E+01	-0.13174E+01	0.30387E+00	0.12396E+01	0.57158E+00	0.12563E+01
23	-0.95426E+00	-0.23151E+00	-0.13306E+01	-0.68143E+00	0.12859E+01	-0.99479E+00	0.92060E+00	0.12924E+01	-0.34807E+00	0.42984E+00
24	-0.95426E+00	-0.45887E+00	-0.12712E+01	-0.10387E+01	0.10685E+01	-0.40541E+00	0.12907E+01	0.74068E+00	-0.11045E+01	-0.70379E+00
25	-0.95426E+00	-0.67228E+00	-0.11732E+01	-0.12707E+01	0.72205E+00	0.29249E+00	0.13149E+01	-0.15770E+00	-0.13444E+01	-0.13345E+01
26	-0.95426E+00	-0.86526E+00	-0.10396E+01	-0.13495E+01	0.28859E+00	0.91205E+00	0.98682E+00	-0.98222E+00	-0.95513E+00	-0.10119E+01
27	-0.95426E+00	-0.10320E+01	-0.87440E+00	-0.12655E+01	-0.17970E+00	0.12871E+01	0.39424E+00	-0.13473E+01	-0.11910E+00	0.33725E-01
28	-0.95426E+00	-0.11673E+01	-0.68258E+00	-0.10289E+01	-0.62630E+00	0.13174E+01	-0.30392E+00	-0.10819E+01	0.77285E+00	0.10553E+01
29	-0.95426E+00	-0.12672E+01	-0.47005E+00	-0.66611E+00	-0.99737E+00	0.99480E+00	-0.92071E+00	-0.31031E+00	0.13031E+01	0.13227E+01
30	-0.95426E+00	-0.13285E+01	-0.24325E+00	-0.22680E+00	-0.12482E+01	0.40550E+00	-0.12908E+01	0.60661E+00	0.12234E+01	0.64530E+00
31	-0.95426E+00	-0.13495E+01	-0.90647E-02	0.24184E+00	-0.13484E+01	-0.29247E+00	-0.13150E+01	0.12395E+01	0.57125E+00	-0.49299E+00
32	-0.95426E+00	-0.13295E+01	0.22543E+00	0.68134E+00	-0.12860E+01	-0.91197E+00	-0.98676E+00	0.12926E+01	-0.34802E+00	-0.12790E+01
33	-0.95426E+00	-0.12691E+01	0.45305E+00	0.10387E+01	-0.10685E+01	-0.12872E+01	-0.39425E+00	0.74065E+00	-0.11046E+01	-0.11515E+01
34	-0.95426E+00	-0.11701E+01	0.66692E+00	0.12707E+01	-0.72206E+00	-0.13175E+01	0.30409E+00	-0.15782E+00	-0.13443E+01	-0.20119E+00
35	-0.95426E+00	-0.10356E+01	0.86051E+00	0.13495E+01	-0.28857E+00	-0.99483E+00	0.92081E+00	-0.98219E+00	-0.95495E+00	0.89282E+00
36	-0.95426E+00	-0.86965E+00	0.10280E+01	0.12655E+01	0.17969E+00	-0.40556E+00	0.12908E+01	-0.13472E+01	-0.11873E+00	0.13490E+01

	11	12	13	14	15	16	17	18	19	20
1	-0.10708E+01	0.76846E+00	0.11043E+01	-0.11760E+01	-0.66746E+00	0.93333E+00	-0.91007E+00	-0.97751E-01	0.13462E+01	-0.95054E+00
2	-0.13173E+01	0.13455E+01	-0.11947E+00	0.22209E+00	-0.13284E+01	0.11235E+01	0.82055E+00	-0.13482E+01	-0.92658E-01	0.11121E+01
3	-0.62404E+00	0.57553E+00	-0.12239E+01	0.13259E+01	-0.24733E+00	-0.54662E+00	0.11992E+01	0.10096E+00	-0.13478E+01	0.56182E+00
4	0.51582E+00	-0.76929E+00	-0.11044E+01	0.68551E+00	0.11621E+01	-0.13125E+01	-0.40609E+00	0.13472E+01	0.93532E-01	-0.13065E+01
5	0.12866E+01	-0.13444E+01	0.11943E+00	-0.85631E+00	0.10413E+01	0.91381E-01	-0.13394E+01	-0.10158E+00	0.13472E+01	-0.10701E+00
6	0.11386E+01	-0.57562E+00	0.12240E+01	-0.12721E+01	-0.44942E+00	0.13438E+01	-0.59806E-01	-0.13466E+01	-0.93246E-01	0.13427E+01
7	0.17765E+00	0.76800E+00	0.11049E+01	-0.13859E-01	-0.13478E+01	0.37471E+00	0.13178E+01	0.10256E+00	-0.13466E+01	-0.35986E+00
8	-0.91104E+00	0.13447E+01	-0.11968E+00	0.12631E+01	-0.47339E+00	-0.12122E+01	0.51839E+00	0.13447E+01	0.92667E-01	-0.12162E+01
9	-0.13483E+01	0.57633E+00	-0.12242E+01	0.87780E+00	0.10250E+01	-0.79672E+00	-0.11383E+01	-0.10137E+00	0.13468E+01	0.78086E+00
10	-0.82272E+00	-0.76805E+00	-0.11048E+01	-0.66268E+00	0.11736E+01	0.93594E+00	-0.91331E+00	-0.13453E+01	-0.92959E-01	0.94609E+00
11	0.29132E+00	-0.13451E+01	0.11957E+00	-0.13310E+01	-0.22180E+00	0.11212E+01	0.82064E+00	0.10201E+00	-0.13464E+01	-0.11107E+01
12	0.11968E+01	-0.57657E+00	0.12244E+01	-0.24794E+00	-0.13258E+01	-0.54610E+00	0.11987E+01	0.13448E+01	0.92941E-01	-0.55956E+00
13	0.12470E+01	0.76871E+00	0.11046E+01	0.11616E+01	-0.68500E+00	-0.13104E+01	-0.40430E+00	-0.10275E+00	0.13462E+01	0.13056E+01
14	0.40585E+00	0.13460E+01	-0.11986E+00	0.10428E+01	0.85673E+00	0.91311E-01	-0.13386E+01	-0.13450E+01	-0.93340E-01	0.10760E+00
15	-0.72403E+00	0.57585E+00	-0.12240E+01	-0.44905E+00	0.12727E+01	0.13405E+01	-0.61528E-01	0.10425E+00	-0.13453E+01	-0.13463E+01
16	-0.13375E+01	-0.76921E+00	-0.11044E+01	-0.13494E+01	0.12318E-01	0.37572E+00	0.13181E+01	0.13438E+01	0.92662E-01	0.36175E+00
17	-0.99482E+00	-0.13458E+01	0.11965E+00	-0.47426E+00	-0.12636E+01	-0.12110E+01	0.51808E+00	-0.10270E+00	0.13457E+01	0.12191E+01
18	0.58367E-01	-0.57605E+00	0.12249E+01	0.10251E+01	-0.87673E+00	-0.79553E+00	-0.11374E+01	-0.13448E+01	-0.92941E-01	-0.78343E+00
19	0.10696E+01	0.76988E+00	0.11041E+01	0.11755E+01	0.66369E+00	0.93493E+00	-0.91291E+00	0.10154E+00	-0.13457E+01	-0.94680E+00
20	0.13172E+01	0.13451E+01	-0.11953E+00	-0.22121E+00	0.13317E+01	0.11192E+01	0.81960E+00	0.13468E+01	0.93282E-01	0.11105E+01
21	0.62372E+00	0.57569E+00	-0.12237E+01	-0.13269E+01	0.24659E+00	-0.54558E+00	0.11974E+01	-0.10174E+00	0.13457E+01	0.56153E+00
22	-0.51561E+00	-0.76936E+00	-0.11042E+01	-0.68638E+00	-0.11636E+01	-0.13088E+01	-0.40359E+00	-0.13470E+01	-0.93321E-01	-0.13049E+01
23	-0.12865E+01	-0.13452E+01	0.11936E+00	0.85726E+00	-0.10417E+01	0.90581E-01	-0.13378E+01	0.10124E+00	-0.13460E+01	-0.10862E+00
24	-0.11388E+01	-0.57527E+00	0.12236E+01	0.12732E+01	0.45031E+00	0.13413E+01	-0.59625E-01	0.13461E+01	0.93307E-01	0.13433E+01
25	-0.17695E+00	0.76931E+00	0.11041E+01	0.13441E-01	0.13505E+01	0.37476E+00	0.13164E+01	-0.10025E+00	0.13463E+01	-0.35811E+00
26	0.91127E+00	0.13447E+01	-0.11917E+00	-0.12639E+01	0.47270E+00	-0.12106E+01	0.51675E+00	-0.13460E+01	-0.93324E-01	-0.12191E+01

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27   0.13487E+01 0.57544E+00-0.12235E+01-0.87808E+00-0.10269E+01-0.79576E+00-0.11375E+01 0.10021E+00-0.13463E+01 0.78099E+00
28   0.82231E+00-0.76920E+00-0.11044E+01 0.66327E+00-0.11751E+01 0.93439E+00-0.91116E+00 0.13458E+01 0.93414E-01 0.94836E+00
29  -0.29158E+00-0.13446E+01 0.11935E+00 0.13316E+01 0.22374E+00 0.11205E+01 0.82131E+00-0.10013E+00 0.13465E+01-0.11102E+01
30  -0.11971E+01-0.57568E+00 0.12236E+01 0.24769E+00 0.13282E+01-0.54523E+00 0.11960E+01-0.13457E+01-0.93616E-01-0.56323E+00
31  -0.12473E+01 0.76878E+00 0.11043E+01-0.11621E+01 0.68442E+00-0.13102E+01-0.40635E+00 0.99706E-01-0.13466E+01 0.13052E+01
32  -0.40638E+00 0.13447E+01-0.11944E+00-0.10426E+01-0.86047E+00 0.90365E-01-0.13371E+01 0.13451E+01 0.94034E-01 0.11084E+00
33   0.72507E+00 0.57565E+00-0.12238E+01 0.44883E+00-0.12725E+01 0.13412E+01-0.57761E-01-0.99027E-01 0.13462E+01-0.13441E+01
34   0.13384E+01-0.76861E+00-0.11043E+01 0.13495E+01-0.96759E-02 0.37584E+00 0.13169E+01-0.13453E+01-0.93731E-01 0.35592E+00
35   0.99546E+00-0.13445E+01 0.11961E+00 0.47455E+00 0.12658E+01-0.12104E+01 0.51501E+00 0.98461E-01-0.13460E+01 0.12207E+01
36  -0.58780E-01-0.57595E+00 0.12237E+01-0.10250E+01 0.87533E+00-0.79670E+00-0.11384E+01 0.13456E+01 0.93360E-01-0.77994E+00
          21          22          23          24          25          26          27          28          29          30
 1   0.93780E+00 0.11609E+01-0.69536E+00 0.96436E+00 0.91355E+00-0.12950E+01 0.38999E+00 0.78115E+00 0.10777E+01 0.13455E+01
 2   0.79216E+00-0.10506E+01-0.84941E+00-0.13018E+01 0.40285E+00 0.11281E+01 0.73898E+00 0.10827E+00-0.13393E+01-0.11377E+01
 3  -0.12126E+01-0.43848E+00 0.12747E+01 0.34040E+00-0.13178E+01-0.16406E+00-0.13357E+01-0.94698E+00 0.96656E+00 0.62781E+00
 4  -0.37137E+00 0.13493E+01-0.21786E-01 0.96084E+00 0.91557E+00-0.91391E+00 0.97719E+00 0.13431E+01-0.13882E+00 0.50561E-01
 5   0.13422E+01-0.48543E+00-0.12604E+01-0.13028E+01 0.40236E+00 0.13400E+01 0.79914E-01-0.11108E+01-0.75512E+00-0.71767E+00
 6  -0.95624E-01-0.10161E+01 0.68465E+00 0.34311E+00-0.13178E+01-0.80886E+00-0.10810E+01 0.35815E+00 0.12984E+01 0.11936E+01
 7  -0.13092E+01 0.11812E+01 0.65567E+00 0.96142E+00 0.91496E+00-0.30280E+00 0.13092E+01 0.56265E+00-0.12338E+01-0.13473E+01
 8   0.55116E+00 0.20633E+00-0.13344E+01-0.13072E+01 0.40318E+00 0.12009E+01-0.60134E+00-0.12203E+01 0.59029E+00 0.11359E+01
 9   0.11173E+01-0.13213E+01 0.25829E+00 0.34704E+00-0.13177E+01-0.12409E+01-0.53620E+00 0.13068E+01 0.33033E+00-0.61760E+00
10  -0.93878E+00 0.69616E+00 0.11573E+01 0.95954E+00 0.91407E+00 0.39335E+00 0.12909E+01-0.78200E+00-0.10974E+01-0.67788E-01
11  -0.79185E+00 0.84654E+00-0.10498E+01-0.13046E+01 0.40363E+00 0.73447E+00-0.11242E+01-0.10823E+00 0.13542E+01 0.73691E+00
12   0.12141E+01-0.12756E+01-0.43935E+00 0.34298E+00-0.13175E+01-0.13355E+01 0.15490E+00 0.94769E+00-0.98075E+00-0.12100E+01
13   0.37046E+00 0.24531E-01 0.13498E+01 0.96117E+00 0.91415E+00 0.98154E+00 0.92587E+00-0.13438E+01 0.14820E+00 0.13577E+01
14  -0.13421E+01 0.12582E+01-0.48481E+00-0.13050E+01 0.40338E+00 0.76291E-01-0.13455E+01 0.11112E+01 0.75275E+00-0.11429E+01
15   0.94202E-01-0.88197E+00-0.10161E+01 0.34711E+00-0.13183E+01-0.10830E+01 0.80269E+00-0.35887E+00-0.12986E+01 0.62572E+00
16   0.13105E+01-0.65681E+00 0.11786E+01 0.95589E+00 0.91567E+00 0.13165E+01 0.31434E+00-0.56099E+00 0.12357E+01 0.56744E-01
17  -0.55020E+00 0.13321E+01 0.21056E+00-0.13010E+01 0.40298E+00-0.60957E+00-0.12075E+01 0.12184E+01-0.59382E+00-0.72207E+00
18  -0.11188E+01-0.25477E+00-0.13234E+01 0.34287E+00-0.13172E+01-0.53213E+00 0.12390E+01-0.13057E+01-0.32691E+00 0.11919E+01
19   0.93892E+00-0.11587E+01 0.69425E+00 0.95788E+00 0.91512E+00 0.12938E+01-0.38551E+00 0.78192E+00 0.10945E+01-0.13428E+01
20   0.79185E+00 0.10489E+01 0.84972E+00-0.12985E+01 0.40182E+00-0.11325E+01-0.74416E+00 0.10772E+00-0.13491E+01 0.11360E+01
21  -0.12139E+01 0.44102E+00-0.12758E+01 0.33990E+00-0.13165E+01 0.16141E+00 0.13423E+01-0.94692E+00 0.97387E+00-0.62460E+00
22  -0.36991E+00-0.13508E+01 0.22733E-01 0.95784E+00 0.91424E+00 0.92590E+00-0.98178E+00 0.13429E+01-0.14505E+00-0.55617E-01
23   0.13420E+01 0.48280E+00 0.12605E+01-0.12968E+01 0.40237E+00-0.13508E+01-0.79655E-01-0.11108E+01-0.75096E+00 0.72125E+00
24  -0.95155E-01 0.10191E+01-0.88593E+00 0.33637E+00-0.13166E+01 0.81073E+00 0.10851E+01 0.35921E+00 0.12944E+01-0.11950E+01
25  -0.13096E+01-0.11786E+01-0.65366E+00 0.96264E+00 0.91457E+00 0.30787E+00-0.13153E+01 0.56063E+00-0.12319E+01 0.13499E+01
26   0.55002E+00-0.21317E+00 0.13331E+01-0.12990E+01 0.40131E+00-0.12057E+01 0.60646E+00-0.12183E+01 0.59412E+00-0.11433E+01
27   0.11184E+01 0.13247E+01-0.25838E+00 0.33577E+00-0.13151E+01 0.12404E+01 0.53550E+00 0.13059E+01 0.32156E+00 0.63050E+00
28  -0.93868E+00-0.69293E+00-0.11560E+01 0.96319E+00 0.91310E+00-0.30674E+00-0.12943E+01-0.78230E+00-0.10874E+01 0.50609E-01
29  -0.79186E+00-0.85115E+00 0.10489E+01-0.12987E+01 0.40218E+00-0.74431E+00 0.11286E+01-0.10787E+00 0.13455E+01-0.71775E+00
30   0.12134E+01 0.12755E+01 0.43870E+00 0.33594E+00-0.13154E+01 0.13427E+01-0.15668E+00 0.94809E+00-0.97472E+00 0.11926E+01
31   0.37025E+00-0.20486E-01-0.13491E+01 0.96291E+00 0.91325E+00-0.98096E+00-0.92789E+00-0.13447E+01 0.14920E+00-0.13467E+01
32  -0.13419E+01-0.12623E+01 0.48339E+00-0.12990E+01 0.40224E+00-0.81995E-01 0.13505E+01 0.11123E+01 0.74542E+00 0.11387E+01
33   0.95852E-01 0.88389E+00 0.10192E+01 0.33589E+00-0.13157E+01 0.10858E+01-0.80919E+00-0.35988E+00-0.12918E+01-0.62452E+00
34   0.13084E+01 0.65795E+00-0.11808E+01 0.96303E+00 0.91354E+00-0.13124E+01-0.30972E+00-0.56047E+00 0.12354E+01-0.57342E-01
35  -0.55000E+00-0.13338E+01-0.21139E+00-0.12984E+01 0.40210E+00 0.59998E+00 0.12074E+01 0.12182E+01-0.60294E+00 0.72330E+00
36  -0.11175E+01 0.25383E+00 0.13256E+01 0.33483E+00-0.13156E+01 0.54123E+00-0.12425E+01-0.13053E+01-0.30965E+00-0.11947E+01
          31          32          33          34          35          36
 1  -0.14069E-01-0.34081E+00 0.13110E+01-0.83659E+00-0.11319E+01 0.92080E+00
 2  -0.66413E+00-0.12708E+00-0.13428E+01 0.10125E+01 0.98694E+00-0.91383E+00
 3   0.11633E+01 0.57870E+00 0.12075E+01-0.11597E+01-0.80667E+00 0.91583E+00
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 4   -0.13505E+01-0.95997E+00-0.92530E+00 0.12722E+01 0.60042E+00-0.91974E+00
 5    0.11761E+01 0.12251E+01 0.53087E+00-0.13443E+01-0.37580E+00 0.92111E+00
 6   -0.68635E+00-0.13422E+01-0.71128E-01 0.13742E+01 0.13882E+00-0.92083E+00
 7    0.13942E-01 0.12977E+01-0.39483E+00-0.13640E+01 0.10016E+00 0.92137E+00
 8    0.66078E+00-0.10965E+01 0.80976E+00 0.13151E+01-0.33330E+00-0.92366E+00
 9   -0.11580E+01 0.76288E+00-0.11256E+01-0.12268E+01 0.55567E+00 0.92645E+00
10    0.13442E+01-0.33732E+00 0.13059E+01 0.11015E+01-0.76143E+00-0.92941E+00
11   -0.11686E+01-0.12928E+00-0.13281E+01-0.94409E+00 0.94318E+00 0.93293E+00
12    0.67932E+00 0.58070E+00 0.11902E+01 0.75830E+00-0.10958E+01-0.93703E+00
13   -0.92420E-02-0.96198E+00-0.91169E+00-0.54743E+00 0.12173E+01 0.93992E+00
14   -0.66328E+00 0.12271E+01 0.52319E+00 0.32079E+00-0.13017E+01-0.94364E+00
15    0.11598E+01-0.13442E+01-0.68028E-01-0.88093E-01 0.13439E+01 0.95034E+00
16   -0.13467E+01 0.12990E+01-0.39717E+00-0.14504E+00-0.13440E+01-0.95834E+00
17    0.11737E+01-0.10967E+01 0.81619E+00 0.37193E+00 0.13022E+01 0.96710E+00
18   -0.68728E+00 0.76172E+00-0.11391E+01-0.58574E+00-0.12192E+01-0.97587E+00
19    0.16216E-01-0.33424E+00 0.13249E+01 0.78229E+00 0.10997E+01 0.98217E+00
20    0.66065E+00-0.13380E+00-0.13492E+01-0.95713E+00-0.94990E+00-0.98541E+00
21   -0.11609E+01 0.58557E+00 0.12118E+01 0.11031E+01 0.77323E+00 0.98717E+00
22    0.13499E+01-0.96662E+00-0.93028E+00-0.12148E+01-0.57369E+00-0.98781E+00
23   -0.11770E+01 0.12314E+01 0.53721E+00 0.12889E+01 0.35647E+00 0.98708E+00
24    0.68773E+00-0.13478E+01-0.81135E-01-0.13220E+01-0.12668E+00-0.98651E+00
25   -0.13230E-01 0.13014E+01-0.38379E+00 0.13139E+01-0.10739E+00 0.98672E+00
26   -0.66483E+00-0.10980E+01 0.80310E+00-0.12656E+01 0.33773E+00-0.98637E+00
27    0.11648E+01 0.76253E+00-0.11253E+01 0.11776E+01-0.55784E+00 0.98504E+00
28   -0.13530E+01-0.33542E+00 0.13120E+01-0.10528E+01 0.76088E+00-0.98299E+00
29    0.11788E+01-0.13231E+00-0.13418E+01 0.89515E+00-0.94070E+00 0.97989E+00
30   -0.68864E+00 0.58418E+00 0.12118E+01-0.70977E+00 0.10914E+01-0.97517E+00
31    0.14013E-01-0.96520E+00-0.93623E+00 0.50223E+00-0.12098E+01 0.96940E+00
32    0.66426E+00 0.12296E+01 0.54779E+00-0.27870E+00 0.12933E+01-0.96327E+00
33   -0.11645E+01-0.13464E+01-0.93258E-01 0.45604E-01-0.13396E+01 0.95695E+00
34    0.13528E+01 0.13022E+01-0.37295E+00 0.18997E+00 0.13467E+01-0.94962E+00
35   -0.11785E+01-0.11016E+01 0.79456E+00-0.42032E+00-0.13138E+01 0.94067E+00
36    0.68856E+00 0.76773E+00-0.11200E+01 0.63812E+00 0.12411E+01-0.93066E+00
+++  CLOSE,  4
+++  OPEN,   3 = DIRTY:CYL.DAA          , Acc= DIRECT , Stat= NEW

 MATRIX APPEARING IN DAA EQUATIONS:

              1           2           3           4           5           6           7           8           9          10
 1    0.27090E+00-0.10410E+00-0.97853E-02-0.63421E-02-0.35930E-02-0.23378E-02-0.16694E-02-0.12965E-02-0.10238E-02-0.84159E-03
 2   -0.10410E+00 0.27089E+00-0.10410E+00-0.97804E-02-0.63444E-02-0.35922E-02-0.23378E-02-0.16689E-02-0.12957E-02-0.10252E-02
 3   -0.97853E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97815E-02-0.63429E-02-0.35911E-02-0.23372E-02-0.16727E-02-0.12941E-02
 4   -0.63421E-02-0.97804E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97840E-02-0.63429E-02-0.35942E-02-0.23338E-02-0.16719E-02
 5   -0.35930E-02-0.63444E-02-0.97815E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97839E-02-0.63429E-02-0.35949E-02-0.23348E-02
 6   -0.23378E-02-0.35922E-02-0.63429E-02-0.97840E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97807E-02-0.63405E-02-0.35958E-02
 7   -0.16694E-02-0.23378E-02-0.35911E-02-0.63429E-02-0.97839E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97861E-02-0.63397E-02
 8   -0.12965E-02-0.16689E-02-0.23372E-02-0.35942E-02-0.63429E-02-0.97807E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97829E-02
 9   -0.10238E-02-0.12957E-02-0.16727E-02-0.23338E-02-0.35949E-02-0.63405E-02-0.97861E-02-0.10410E+00 0.27090E+00-0.10410E+00
10   -0.84159E-03-0.10252E-02-0.12941E-02-0.16719E-02-0.23348E-02-0.35958E-02-0.63397E-02-0.97829E-02-0.10410E+00 0.27090E+00
11   -0.72965E-03-0.84167E-03-0.10249E-02-0.12960E-02-0.16698E-02-0.23363E-02-0.35959E-02-0.63405E-02-0.97820E-02-0.10410E+00
12   -0.62715E-03-0.72974E-03-0.84345E-03-0.10239E-02-0.12957E-02-0.16707E-02-0.23336E-02-0.35965E-02-0.63423E-02-0.97821E-02
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13  -0.57183E-03-0.62780E-03-0.72690E-03-0.84285E-03-0.10250E-02-0.12948E-02-0.16717E-02-0.23363E-02-0.35924E-02-0.63415E-02
14  -0.50721E-03-0.56815E-03-0.63017E-03-0.72772E-03-0.84418E-03-0.10237E-02-0.12944E-02-0.16712E-02-0.23366E-02-0.35942E-02
15  -0.48505E-03-0.51023E-03-0.56517E-03-0.63146E-03-0.72721E-03-0.84447E-03-0.10237E-02-0.12954E-02-0.16689E-02-0.23381E-02
16  -0.45271E-03-0.48327E-03-0.51233E-03-0.56698E-03-0.62673E-03-0.72934E-03-0.84446E-03-0.10230E-02-0.12978E-02-0.16692E-02
17  -0.43767E-03-0.45248E-03-0.48447E-03-0.50889E-03-0.56996E-03-0.62712E-03-0.72820E-03-0.84378E-03-0.10230E-02-0.12964E-02
18  -0.42590E-03-0.43612E-03-0.45290E-03-0.48355E-03-0.50894E-03-0.56780E-03-0.62927E-03-0.72841E-03-0.84448E-03-0.10229E-02
19  -0.42270E-03-0.42825E-03-0.43478E-03-0.45428E-03-0.48487E-03-0.51118E-03-0.56673E-03-0.62782E-03-0.72814E-03-0.84370E-03
20  -0.42591E-03-0.42613E-03-0.42621E-03-0.43421E-03-0.45397E-03-0.48289E-03-0.50998E-03-0.56920E-03-0.62878E-03-0.72833E-03
21  -0.43767E-03-0.42579E-03-0.42515E-03-0.42723E-03-0.43571E-03-0.45282E-03-0.48400E-03-0.50879E-03-0.56920E-03-0.62811E-03
22  -0.45270E-03-0.43394E-03-0.43067E-03-0.42273E-03-0.42575E-03-0.43587E-03-0.45452E-03-0.48420E-03-0.51021E-03-0.56800E-03
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24  -0.50719E-03-0.48323E-03-0.45587E-03-0.43424E-03-0.42754E-03-0.42560E-03-0.42507E-03-0.43581E-03-0.45392E-03-0.48536E-03
25  -0.57185E-03-0.50849E-03-0.48273E-03-0.45286E-03-0.43692E-03-0.42547E-03-0.42626E-03-0.42695E-03-0.43423E-03-0.45297E-03
26  -0.62714E-03-0.57049E-03-0.50847E-03-0.48517E-03-0.45309E-03-0.43520E-03-0.42430E-03-0.42818E-03-0.42710E-03-0.43338E-03
27  -0.72967E-03-0.62601E-03-0.57106E-03-0.50836E-03-0.48364E-03-0.45372E-03-0.43761E-03-0.42538E-03-0.42322E-03-0.42866E-03
28  -0.84157E-03-0.73060E-03-0.62586E-03-0.57066E-03-0.50711E-03-0.48689E-03-0.45122E-03-0.43417E-03-0.42859E-03-0.42647E-03
29  -0.10238E-02-0.84305E-03-0.73066E-03-0.62540E-03-0.57095E-03-0.50689E-03-0.48671E-03-0.45377E-03-0.43356E-03-0.42660E-03
30  -0.12965E-02-0.10215E-02-0.84455E-03-0.72949E-03-0.62869E-03-0.56625E-03-0.51059E-03-0.48394E-03-0.45552E-03-0.43244E-03
31  -0.16694E-02-0.12977E-02-0.10209E-02-0.84432E-03-0.72860E-03-0.62959E-03-0.56888E-03-0.50674E-03-0.48522E-03-0.45459E-03
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33  -0.35930E-02-0.23386E-02-0.16683E-02-0.12966E-02-0.10220E-02-0.84498E-03-0.72772E-03-0.62645E-03-0.57020E-03-0.51034E-03
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         11          12          13          14          15          16          17          18          19          20
 1  -0.72965E-03-0.62715E-03-0.57183E-03-0.50721E-03-0.48505E-03-0.45271E-03-0.43767E-03-0.42590E-03-0.42270E-03-0.42591E-03
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10  -0.10410E+00-0.97821E-02-0.63415E-02-0.35942E-02-0.23381E-02-0.16692E-02-0.12964E-02-0.10229E-02-0.84370E-03-0.72833E-03
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13  -0.97856E-02-0.10410E+00 0.27089E+00-0.10410E+00-0.97833E-02-0.63405E-02-0.35935E-02-0.23370E-02-0.16702E-02-0.12969E-02
14  -0.63414E-02-0.97818E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97879E-02-0.63404E-02-0.35931E-02-0.23363E-02-0.16703E-02
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16  -0.23363E-02-0.35928E-02-0.63405E-02-0.97879E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97830E-02-0.63401E-02-0.35925E-02
17  -0.16700E-02-0.23367E-02-0.35935E-02-0.63404E-02-0.97831E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97877E-02-0.63405E-02
18  -0.12967E-02-0.16705E-02-0.23370E-02-0.35931E-02-0.63441E-02-0.97830E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97846E-02
19  -0.10226E-02-0.12965E-02-0.16702E-02-0.23363E-02-0.35933E-02-0.63401E-02-0.97877E-02-0.10410E+00 0.27089E+00-0.10410E+00
20  -0.84410E-03-0.10232E-02-0.12969E-02-0.16703E-02-0.23382E-02-0.35925E-02-0.63405E-02-0.97846E-02-0.10410E+00 0.27090E+00
21  -0.72811E-03-0.84395E-03-0.10234E-02-0.12944E-02-0.16699E-02-0.23381E-02-0.35930E-02-0.63432E-02-0.97835E-02-0.10410E+00
22  -0.62790E-03-0.72801E-03-0.84192E-03-0.10272E-02-0.12946E-02-0.16702E-02-0.23364E-02-0.35930E-02-0.63424E-02-0.97834E-02
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27	-0.43487E-03	-0.45559E-03	-0.48254E-03	-0.50902E-03	-0.56873E-03	-0.62730E-03	-0.73139E-03	-0.83984E-03	-0.10267E-02	-0.12925E-02
28	-0.42692E-03	-0.43292E-03	-0.45451E-03	-0.48447E-03	-0.50875E-03	-0.56856E-03	-0.62795E-03	-0.73003E-03	-0.84261E-03	-0.10246E-02
29	-0.42271E-03	-0.43053E-03	-0.43452E-03	-0.45522E-03	-0.48294E-03	-0.50845E-03	-0.56896E-03	-0.62831E-03	-0.72785E-03	-0.84402E-03
30	-0.43027E-03	-0.42158E-03	-0.42837E-03	-0.43372E-03	-0.45611E-03	-0.48317E-03	-0.50917E-03	-0.56893E-03	-0.62807E-03	-0.72813E-03
31	-0.43332E-03	-0.42822E-03	-0.42612E-03	-0.42660E-03	-0.43184E-03	-0.45593E-03	-0.48536E-03	-0.50827E-03	-0.56854E-03	-0.62756E-03
32	-0.45637E-03	-0.43461E-03	-0.42584E-03	-0.42265E-03	-0.43137E-03	-0.43275E-03	-0.45247E-03	-0.48551E-03	-0.50902E-03	-0.57048E-03
33	-0.48324E-03	-0.45375E-03	-0.43391E-03	-0.43089E-03	-0.42276E-03	-0.42715E-03	-0.43336E-03	-0.45609E-03	-0.48250E-03	-0.51106E-03
34	-0.50842E-03	-0.48206E-03	-0.45571E-03	-0.43418E-03	-0.42616E-03	-0.42750E-03	-0.42817E-03	-0.43064E-03	-0.45732E-03	-0.47994E-03
35	-0.56711E-03	-0.51320E-03	-0.48140E-03	-0.45457E-03	-0.43370E-03	-0.42736E-03	-0.42426E-03	-0.43025E-03	-0.43141E-03	-0.45698E-03
36	-0.63116E-03	-0.56578E-03	-0.51115E-03	-0.48152E-03	-0.45764E-03	-0.43200E-03	-0.42856E-03	-0.42328E-03	-0.42974E-03	-0.43324E-03

	21	22	23	24	25	26	27	28	29	30
1	-0.43767E-03	-0.45270E-03	-0.48506E-03	-0.50719E-03	-0.57185E-03	-0.62714E-03	-0.72967E-03	-0.84157E-03	-0.10238E-02	-0.12965E-02
2	-0.42579E-03	-0.43394E-03	-0.45525E-03	-0.48323E-03	-0.50849E-03	-0.57049E-03	-0.62601E-03	-0.73060E-03	-0.84305E-03	-0.10215E-02
3	-0.42515E-03	-0.43067E-03	-0.43092E-03	-0.45587E-03	-0.48273E-03	-0.50847E-03	-0.57106E-03	-0.62586E-03	-0.73066E-03	-0.84455E-03
4	-0.42723E-03	-0.42273E-03	-0.43048E-03	-0.43424E-03	-0.45286E-03	-0.48517E-03	-0.50836E-03	-0.57066E-03	-0.62540E-03	-0.72949E-03
5	-0.43571E-03	-0.42575E-03	-0.42370E-03	-0.42754E-03	-0.43692E-03	-0.45309E-03	-0.48364E-03	-0.50711E-03	-0.57095E-03	-0.62859E-03
6	-0.45282E-03	-0.43587E-03	-0.42782E-03	-0.42560E-03	-0.42547E-03	-0.43520E-03	-0.45372E-03	-0.48689E-03	-0.50689E-03	-0.56625E-03
7	-0.48400E-03	-0.45452E-03	-0.43561E-03	-0.42507E-03	-0.42626E-03	-0.42430E-03	-0.43761E-03	-0.45122E-03	-0.48671E-03	-0.51059E-03
8	-0.50879E-03	-0.48420E-03	-0.45278E-03	-0.43581E-03	-0.42695E-03	-0.42818E-03	-0.42538E-03	-0.43417E-03	-0.45377E-03	-0.48394E-03
9	-0.56920E-03	-0.51021E-03	-0.48277E-03	-0.45392E-03	-0.43423E-03	-0.42710E-03	-0.42322E-03	-0.42859E-03	-0.43356E-03	-0.45552E-03
10	-0.62811E-03	-0.56800E-03	-0.51044E-03	-0.48536E-03	-0.45297E-03	-0.43338E-03	-0.42866E-03	-0.42647E-03	-0.42660E-03	-0.43244E-03
11	-0.72311E-03	-0.62790E-03	-0.56928E-03	-0.50782E-03	-0.48613E-03	-0.45280E-03	-0.43487E-03	-0.42692E-03	-0.42271E-03	-0.43027E-03
12	-0.84395E-03	-0.72801E-03	-0.62940E-03	-0.56729E-03	-0.50711E-03	-0.48613E-03	-0.45559E-03	-0.43292E-03	-0.43053E-03	-0.42158E-03
13	-0.10234E-02	-0.84192E-03	-0.72800E-03	-0.62982E-03	-0.57135E-03	-0.50677E-03	-0.48254E-03	-0.45451E-03	-0.43452E-03	-0.42837E-03
14	-0.12944E-02	-0.10272E-02	-0.84179E-03	-0.72807E-03	-0.62734E-03	-0.57012E-03	-0.50902E-03	-0.48447E-03	-0.45522E-03	-0.43372E-03
15	-0.16699E-02	-0.12946E-02	-0.10232E-02	-0.84404E-03	-0.72813E-03	-0.62853E-03	-0.56873E-03	-0.50875E-03	-0.48294E-03	-0.45611E-03
16	-0.23381E-02	-0.16702E-02	-0.12969E-02	-0.10232E-02	-0.84420E-03	-0.72938E-03	-0.62730E-03	-0.56856E-03	-0.50845E-03	-0.48317E-03
17	-0.35930E-02	-0.23364E-02	-0.16639E-02	-0.12965E-02	-0.10225E-02	-0.84208E-03	-0.73139E-03	-0.62795E-03	-0.56896E-03	-0.50917E-03
18	-0.63432E-02	-0.35930E-02	-0.23369E-02	-0.16704E-02	-0.12967E-02	-0.10243E-02	-0.83984E-03	-0.73003E-03	-0.62831E-03	-0.56893E-03
19	-0.97835E-02	-0.63424E-02	-0.35928E-02	-0.23366E-02	-0.16700E-02	-0.12949E-02	-0.10267E-02	-0.84261E-03	-0.72785E-03	-0.62807E-03
20	-0.10410E+00	-0.97834E-02	-0.63427E-02	-0.35932E-02	-0.23369E-02	-0.16715E-02	-0.12925E-02	-0.10246E-02	-0.84402E-03	-0.72813E-03
21	0.27090E+00	-0.10410E+00	-0.97833E-02	-0.63424E-02	-0.35925E-02	-0.23349E-02	-0.16733E-02	-0.12962E-02	-0.10228E-02	-0.84415E-03
22	-0.10410E+00	0.27090E+00	-0.10410E+00	-0.97839E-02	-0.63428E-02	-0.35940E-02	-0.23357E-02	-0.16698E-02	-0.12960E-02	-0.10219E-02
23	-0.97833E-02	-0.10410E+00	0.27090E+00	-0.10410E+00	-0.97833E-02	-0.63428E-02	-0.35926E-02	-0.23365E-02	-0.16691E-02	-0.12987E-02
24	-0.63424E-02	-0.97839E-02	-0.10410E+00	0.27090E+00	-0.10410E+00	-0.97845E-02	-0.63427E-02	-0.35932E-02	-0.23379E-02	-0.16693E-02
25	-0.35925E-02	-0.63428E-02	-0.97833E-02	-0.10410E+00	0.27089E+00	-0.10410E+00	-0.97819E-02	-0.63432E-02	-0.35927E-02	-0.23376E-02
26	-0.23349E-02	-0.35940E-02	-0.63428E-02	-0.97845E-02	-0.10410E+00	0.27089E+00	-0.10410E+00	-0.97815E-02	-0.63459E-02	-0.35899E-02
27	-0.16733E-02	-0.23357E-02	-0.35926E-02	-0.63427E-02	-0.97819E-02	-0.10410E+00	0.27090E+00	-0.10410E+00	-0.97814E-02	-0.63455E-02
28	-0.12962E-02	-0.16698E-02	-0.23365E-02	-0.35932E-02	-0.63432E-02	-0.97815E-02	-0.10410E+00	0.27090E+00	-0.10410E+00	-0.97811E-02
29	-0.10228E-02	-0.12960E-02	-0.16691E-02	-0.23379E-02	-0.35927E-02	-0.63459E-02	-0.97814E-02	-0.10410E+00	0.27090E+00	-0.10410E+00
30	-0.84415E-03	-0.10219E-02	-0.12987E-02	-0.16693E-02	-0.23376E-02	-0.35899E-02	-0.63455E-02	-0.97811E-02	-0.10410E+00	0.27090E+00
31	-0.72954E-03	-0.84593E-03	-0.10199E-02	-0.12958E-02	-0.16717E-02	-0.23374E-02	-0.35917E-02	-0.63431E-02	-0.97846E-02	-0.10410E+00
32	-0.62680E-03	-0.72622E-03	-0.84802E-03	-0.10207E-02	-0.12951E-02	-0.16701E-02	-0.23390E-02	-0.35919E-02	-0.63407E-02	-0.97864E-02
33	-0.56754E-03	-0.62818E-03	-0.72629E-03	-0.84748E-03	-0.10220E-02	-0.12963E-02	-0.16694E-02	-0.23380E-02	-0.35941E-02	-0.63408E-02
34	-0.50987E-03	-0.57176E-03	-0.62711E-03	-0.72770E-03	-0.84564E-03	-0.10208E-02	-0.12960E-02	-0.16704E-02	-0.23374E-02	-0.35944E-02
35	-0.48360E-03	-0.50899E-03	-0.56797E-03	-0.62886E-03	-0.72558E-03	-0.84816E-03	-0.10209E-02	-0.12954E-02	-0.16700E-02	-0.23361E-02
36	-0.45526E-03	-0.48134E-03	-0.51261E-03	-0.56646E-03	-0.63044E-03	-0.72506E-03	-0.84681E-03	-0.10238E-02	-0.12951E-02	-0.16698E-02

	31	32	33	34	35	36
1	-0.16694E-02	-0.23378E-02	-0.35930E-02	-0.63421E-02	-0.97853E-02	-0.10410E+00
2	-0.12977E-02	-0.16694E-02	-0.23386E-02	-0.35899E-02	-0.63420E-02	-0.97871E-02
3	-0.10209E-02	-0.12969E-02	-0.16683E-02	-0.23398E-02	-0.35931E-02	-0.63404E-02

```
  4  -0.84432E-03-0.10234E-02-0.12966E-02-0.16695E-02-0.23375E-02-0.35919E-02
  5  -0.72860E-03-0.84306E-03-0.10220E-02-0.12992E-02-0.16692E-02-0.23355E-02
  6  -0.62959E-03-0.72966E-03-0.84498E-03-0.10197E-02-0.12963E-02-0.16734E-02
  7  -0.56888E-03-0.62618E-03-0.72772E-03-0.84420E-03-0.10245E-02-0.12951E-02
  8  -0.50674E-03-0.57198E-03-0.62645E-03-0.72973E-03-0.84344E-03-0.10224E-02
  9  -0.48522E-03-0.50714E-03-0.57020E-03-0.62901E-03-0.72802E-03-0.84245E-03
 10  -0.45459E-03-0.48299E-03-0.51034E-03-0.56920E-03-0.62707E-03-0.72920E-03
 11  -0.43332E-03-0.45637E-03-0.48324E-03-0.50842E-03-0.56711E-03-0.63116E-03
 12  -0.42822E-03-0.43461E-03-0.45375E-03-0.48206E-03-0.51320E-03-0.56578E-03
 13  -0.42612E-03-0.42584E-03-0.43391E-03-0.45571E-03-0.48140E-03-0.51115E-03
 14  -0.42660E-03-0.42265E-03-0.43089E-03-0.43418E-03-0.45457E-03-0.48152E-03
 15  -0.43184E-03-0.43137E-03-0.42276E-03-0.42616E-03-0.43370E-03-0.45764E-03
 16  -0.45593E-03-0.43275E-03-0.42715E-03-0.42750E-03-0.42736E-03-0.43200E-03
 17  -0.48536E-03-0.45247E-03-0.43336E-03-0.42817E-03-0.42426E-03-0.42856E-03
 18  -0.50827E-03-0.48551E-03-0.45609E-03-0.43064E-03-0.43025E-03-0.42328E-03
 19  -0.56854E-03-0.50902E-03-0.48250E-03-0.45732E-03-0.43141E-03-0.42974E-03
 20  -0.62756E-03-0.57048E-03-0.51106E-03-0.47994E-03-0.45698E-03-0.43324E-03
 21  -0.72954E-03-0.62680E-03-0.56754E-03-0.50987E-03-0.48350E-03-0.45526E-03
 22  -0.84593E-03-0.72622E-03-0.62818E-03-0.57176E-03-0.50899E-03-0.48134E-03
 23  -0.10199E-02-0.84802E-03-0.72629E-03-0.62711E-03-0.56797E-03-0.51261E-03
 24  -0.12958E-02-0.10207E-02-0.84748E-03-0.72770E-03-0.62886E-03-0.56646E-03
 25  -0.16717E-02-0.12951E-02-0.10220E-02-0.84564E-03-0.72558E-03-0.63044E-03
 26  -0.23374E-02-0.16701E-02-0.12963E-02-0.10208E-02-0.84816E-03-0.72506E-03
 27  -0.35917E-02-0.23390E-02-0.16694E-02-0.12960E-02-0.10209E-02-0.84681E-03
 28  -0.63431E-02-0.35919E-02-0.23380E-02-0.16704E-02-0.12954E-02-0.10238E-02
 29  -0.97846E-02-0.63407E-02-0.35941E-02-0.23374E-02-0.16700E-02-0.12951E-02
 30  -0.10410E+00-0.97864E-02-0.63408E-02-0.35944E-02-0.23361E-02-0.16698E-02
 31   0.27090E+00-0.10410E+00-0.97829E-02-0.63428E-02-0.35948E-02-0.23351E-02
 32  -0.10410E+00 0.27090E+00-0.10410E+00-0.97804E-02-0.63422E-02-0.35962E-02
 33  -0.97829E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97826E-02-0.63413E-02
 34  -0.63428E-02-0.97804E-02-0.10410E+00 0.27090E+00-0.10410E+00-0.97825E-02
 35  -0.35948E-02-0.63422E-02-0.97826E-02-0.10410E+00 0.27090E+00-0.10410E+00
 36  -0.23351E-02-0.35962E-02-0.63413E-02-0.97825E-02-0.10410E+00 0.27089E+00

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E               +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                        +
+LDI Ext-filnam Unit EC Upt PRU  Cdloc   Next  Limit      Read Written +
+  3 DIRTY:CYL.DA  3  1 UPR  64     21     21 100000         0    1296 +
+    A                                                                   +
+                                                                        +
+                    1 Active devices ( 0 full)                          +
+     0 Tp ops,    16 Writes,      1 Reads        5947 Words XFD         +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE,  3
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APPENDIX D

USER INFORMATION FOR THE AUGMENTED MATRIX PREPROCESSOR AUGMAT

This appendix includes a copy of the users manual, and a sample input deck and subsequent output for the infinite cylindrical shell problem presented in Section 4.

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                              A U G M A T

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      THIS FUNCTIONAL COMPONENT OF THE UNDERWATER SHOCK ANALYSIS CODE
      ACCEPTS DATA FROM THE FLUID MASS MATRIX PROCESSOR AND THE
      STRUCTURAL ANALYZER TO CONSTRUCT THE SPECIFIC CONSTANTS AND ARRAYS
      THAT ARE USED IN THE STAGGERED SOLUTION PROCEDURE FOR THE
      TRANSIENT RESPONSE ANALYSIS OF SUBMERGED STRUCTURES

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      THIS PROGRAM WAS DEVELOPED AND CODED BY JOHN A. DERUNTZ, JR.
      OF LOCKHEED MISSILES AND SPACE CO. RESEARCH LABS IN PALO ALTO
      CALIFORNIA. PLEASE CONSULT WITH AUTHOR BEFORE MAKING CHANGES
      AND ALSO REPORT ANY MALFUNCTIONS OR PROBLEMS. WRITE IN CARE OF
      LOCKHEED PALO ALTO RESEARCH LABORATORY, BLDG 205, DEPT 52-33,
      3251 HANOVER ST., PALO ALTO, CALIF., 94304 OR CALL 415-493-4411
      EXTS. 45069 OR 45*33.                              SEPTEMBER, 1980

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  W A R N I N G    F R O M    T H E    P R O G R A M M E R    G E N E R A L

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      THIS CODE CONTAINS THE SPECIAL INGREDIENT DMGASP NOT FOUND IN
      OTHER BRANDS. DMGASP IS A DATA MANAGEMENT UTILITY MODULE THAT
      WILL ACTIVATE AND DEACTIVATE ALL AUXILIARY STORAGE DATA FILES
      REFERENCED BY THE CODE. HENCE THE NAMES OF SUCH FILES SHOULD NOT
      APPEAR ON ANY CONTROL CARDS IN THE RUN STREAM WHICH MIGHT NORMALLY
      ACTIVATE AND DEACTIVATE THE FILES. THE USER IS ALSO CAUTIONED THAT
      PREVIOUSLY CREATED FILES MUST ALREADY BE RESIDENT IN THE SYSTEM
      BEFORE THE RUN IS INITIATED. IF A FILE HAS BEEN ROLLED-OUT TO TAPE
      DMGASP WILL ATTEMPT TO HAVE THE FILE ROLLED-IN EVERY 15 SECONDS
      FOR UP TO 6 MINUTES ON THE UNIVAC 1100-EXEC 8 OPERATING SYSTEM.
      IF AN EXISTING DATA FILE HAS NOT BEEN REFERENCED FOR SOME TIME IT
      IS THEREFORE GOOD POLICY TO SIMPLY ACTIVATE AND DEACTIVATE THE
      FILE BEFORE EXECUTION OF THIS CODE. IF THE USER ATTEMPTS TO CREATE
      A NEW DATA FILE WITH A NAME WHICH IS ALREADY ASSIGNED TO AN
      EXISTING FILE, THE UNIVAC VERSION OF DMGASP WILL MODIFY THE NAME
      OF THE FILE GENERATED BY THIS RUN TO AVOID ANY CONFLICT. FILE NAME
      DUPLICATION WILL CAUSE NO PROBLEM ON THE CDC SCOPE OPERATING
      SYSTEM AS SCOPE WILL SIMPLY CATALOG A NEW CYCLE OF THE SAME FILE.
      ON THE OTHER HAND THE CDC NOS SYSTEM IS SIMILAR TO UNIVAC IN THIS
      REGARD AND THE RUN WILL ABORT SINCE THE NAME-CHANGING FEATURE OF
      DMGASP HAS NOT BEEN IMPLEMENTED FOR NOS. QUALIFIER*FILENAME IS THE
      REQUIRED INPUT DATA FORMAT FOR ALL UNIVAC PERMANENT FILE NAMES.
      ON CDC SCOPE, THE QUALIFIER IS INTERPRETED AS THE USERS ID, WHICH
      IN MOST INSTALLATIONS CAN BE SELECTED ALMOST ARBITRARILY. ON CDC
      NOS, THE QUALIFIER IS INTERPRETED AS THE USERS CATALOG NUMBER,
      WHICH IS USUALLY PRESCRIBED BY THE INSTALLATION. A CYCLE NUMBER
      CAN ALSO BE APPENDED TO GIVE THE FORM QUALIFIER*FILENAME(CYCLE)
      ON CDC SCOPE

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                         P R O G R A M     S I Z E
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      ALL ARRAYS REFERRENCED IN THIS CODE THAT ARE PROBLEM DEPENDENT
      RESIDE IN BLANK COMMON. THE SIZE OF BLANK COMMON IS DETERMINED BY
      A PARAMETER STATEMENT IN THE MAIN PROGRAM FOR THE UNIVAC 1100-OS
      VERSION, HENCE A RECOMPILATION IS NECESSARY TO INCREASE OR
      DECREASE CORE ALLOCATION. IN THE CDC 6600 VERSION RECOMPILATION IS
      UNNECESSARY AS THE LENGTH OF BLANK COMMON IS SET BY A FIELD LENGTH
      REQUEST IN THE CONTROL CARD DECK

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      D E F I N I T I O N    O F    I N P U T    P A R A M E T E R S

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      INPUT VARIABLE NAMES GIVEN BELOW ARE GENERALLY THOSE WHICH ARE
      ALSO USED IN THE CODING AND THE VARIABLE TYPES CORRESPOND TO
      STANDARD FORTRAN USAGE:

                     A   -   ALPHANUMERIC
                     E   -   FLOATING POINT
                     F   -   FIXED POINT
                     I   -   INTEGER
                     L   -   LOGICAL

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      VARIABLE    TYPE                   DESCRIPTION
      --------    ----                   -----------

      STRNAM       A         NAME OF PERMANENT MASS STORAGE FILE WHICH
                             CONTAINS THE STRUCTURAL MASS AND STIFFNESS
                             MATRICES AS WELL AS BOOKEEPING INFORMATION
                             RELATING THE INTERNAL AND EXTERNAL DEGREES
                             OF FREEDOM. WHEN INTERFACING WITH THE
                             NONLINEAR STRUCTURAL ANALYZER STAGS THE
                             STIFFNESS MATRIX IS NOT PRESENT

      FLUNAM       A         NAME OF PERMANENT MASS STORAGE FILE WHICH
                             CONTAINS THE MANIPULATED DAA FORM OF THE
                             FLUID MASS MATRIX

      GEONAM       A         NAME OF PERMANENT MASS STORAGE FILE WHICH
                             CONTAINS THE FLUID MESH GEOMETRY AND
                             FLUID-STRUCTURE TRANSFORMATION DATA

      PRENAM       A         NAME OF PERMANENT MASS STORAGE FILE
                             CREATED BY THIS PROCESSOR WHICH CONTAINS
                             ALL THE INFORMATION REQUIRED TO CONDUCT
                             THE UNDERWATER SHOCK ANALYSIS OF THE
                             STRUCTURE IN QUESTION EXCEPT FOR THE
                             EXCITATION AND INTEGRATION DATA

      FRWTST       L         TRUE IF THE PERMANENT FILE CONTAINING THE
                             STRUCTURAL MASS AND STIFFNESS MATRICES
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		WAS CREATED BY BUFFERED FORTRAN WRITE STATEMENTS. OTHERWISE FALSE
SYMCON	L	TRUE IF TRANSLATIONAL CONSTRAINTS MUST BE APPLIED TO STRUCTURAL NODES DUE TO SYMMETRY CONDITIONS IF HALF OR QUARTER MODELS ARE BEING USED, OTHERWISE FALSE. CONSTRAINTS ON ROTATIONAL STRUCTURAL FREEDOMS DO NOT ENTER THE AUGMENTED MATRICES. CONSTRAINTS MUST BE APPLIED ONLY IF NDICOS = 0 (SEE BELOW)
PRTAUG	L	TRUE IF AUGMENTED FORM OF MATRICES APPEARING IN THE FLUID EQUATIONS ARE TO BE PRINTED IN FULL. OTHERWISE FALSE IN WHICH CASE ONLY THE MATRIX MASTER RECORD AND THE DIAGONAL TERMS ARE PRINTED. THE FIRST MATRIX SHOWN IS THE INVERSE FORM OF THE STRUCTURAL MASS AND IT IS THE ONLY SPARSE MATRIX IN THE FLUID EQUATIONS, HENCE A MAP OF ITS CONNECTIVITY IS ALWAYS SHOWN. THE NEXT MATRIX IS A COMBINATION OF BOTH THE FLUID AND STRUCTURE INVERSE MASS MATRICES. FOR DAA2 RUNS TWO ADDITIONAL MATRICES APPEAR THAT INVOLVE ONLY THE FLUID MASS INVERSE. THE FIRST COMES DIRECTLY FROM THE DAA1 EQUATION WHILE THE SECOND IS ITS ITERATED FORM THAT APPEARS IN THE DAA2 EQUATION. IT IS RECOMMENDED THAT A VALUE OF FALSE BE USED UNDER NORMAL CONDITIONS
PRTGMT	L	TRUE IF FLUID MESH GEOMETRY DATA IS TO BE LISTED, OTHERWISE FALSE
PRTTRN	L	TRUE IF FLUID-STRUCTURE TRANSFORMATION DATA IS TO BE LISTED, OTHERWISE FALSE
PRTSTF	L	TRUE IF SKYLINED STRUCTURAL STIFFNESS MATRIX IS TO BE DISPLAYED, OTHERWISE FALSE. WHEN INTERFACING WITH STAGS THIS VARIABLE MUST ALWAYS BE TAKEN AS FALSE SINCE THE GLOBAL STIFFNESS OPERATOR DOES NOT EXIST IN THE SAME FORM AS THAT FOR USA IN THE STAND ALONE CONFIGURATION
DAA2	E,F	A PARAMETER BOUNDED BY ZERO AND UNITY THAT GOVERNS THE USE OF THE IMPROVED DOUBLY ASYMPTOTIC APPROXIMATION. A VALUE OF ZERO REDUCES THE FLUID SOLUTION TO THE STANDARD DOUBLY ASYMPTOTIC APPROXIMATION, HOWEVER A PRECISE CHOICE FOR THIS PARAMETER IS NOT GIVEN BY ANY FUNDAMENTAL PRINCIPLE. IT HAS BEEN OBSERVED THAT A VALUE OF 1.0 LEADS TO THE BEST ACCURACY FOR A SPHERICAL SHELL WHILE A VALUE OF 0.5 SEEMS TO BE BEST FOR THE INFINITE CYLINDRICAL SHELL. IT CAN BE SHOWN THAT THIS SCALAR PARAMETER DOES HAVE A RELATIONSHIP WITH THE DIAGONAL LOCAL

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                                CURVATURE MATRIX FOR THE FLUID ELEMENTS.
                                IF A VALUE OF ZERO WAS USED IN THE FLUID
                                MASS RUN AND A DAA2 RUN IS DESIRED THEN
                                THE FLUID MASS PROCESSOR MUST BE RERUN
                                WITH A NONZERO VALUE BEFORE FURTHER
                                COMPUTATION CAN TAKE PLACE

          NSTR         I        NUMBER OF NODE POINTS IN STRUCTURAL MODEL

          NSFR         I        NUMBER OF STRUCTURAL DEGREES OF FREEDOM.
                                WHEN INTERFACING WITH STAGS THIS WILL BE
                                SIX (6) TIMES THE VALUE OF NSTR

          NFRE         I        THE LARGEST DEGREE OF FREEDOM INDEX AT ANY
                                STRUCTURAL NODE WHICH IS REFERENCED IN THE
                                ANALYSIS. FREEDOMS 1, 2, AND 3 ARE ASSUMED
                                TO BE TRANSLATIONAL WHILE 4, 5, AND 6 ARE
                                RESERVED FOR ROTATIONS. ALWAYS USE SIX (6)
                                WHEN INTERFACING WITH STAGS

          NFTR         I        THE LARGEST TRANSLATIONAL DEGREE OF
                                FREEDOM INDEX AT ANY NODE WHICH IS
                                REFERENCED IN THE ANALYSIS. ALWAYS USE
                                THREE (3) WHEN INTERFACING WITH STAGS

          MXWD         I        NUMBER OF WORDS PER BLOCK TO BE USED FOR
                                PARTITIONED SKYLINED FLUID MATRICES.
                                GENERALLY USE SOME MULTIPLE OF 448 TO
                                ACCOMODATE EITHER THE 28 WORD SECTOR ON
                                UNIVAC OR THE 64 WORD PRU ON CDC SO THAT
                                FILE SIZE IS MINIMIZED

          NUMBLK       I        NUMBER OF BLOCKS OR MATRIX VALUE RECORDS
                                INTO WHICH THE SKYLINED STRUCTURAL
                                STIFFNESS MATRIX HAS BEEN PARTITIONED

          NWDBLK       I        MAXIMUM BLOCK SIZE FOR SKYLINED STRUCTURAL
                                STIFFNESS MATRIX

          NSETLC       I        NUMBER OF DATA SETS NEEDED TO DEFINE THE
                                TYPE OF STRUCTURAL COORDINATE SYSTEM WITH
                                WHICH ANY PARTICULAR GENERAL FLUID ELEMENT
                                MUST INTERFACE. THIS DATA IS NOT REQUIRED
                                FOR SURFACE OF REVOLUTION FLUID ELEMENTS
                                BUT INCLUDES ANY FLUID ELEMENTS THAT WERE
                                GENERATED AUTOMATICALLY IN FLUMAS FOR A
                                CYLINDRICAL SURFACE

          NDICOS       I        DESIGNATES THE TYPE OF COORDINATE SYSTEM
                                USED IN THE STRUCTURAL SOLUTION.
                                ACCEPTABLE VALUES ARE:

                                  0 - GLOBAL COORDINATES
                                  1 - LOCAL COORDINATES WITH THE FIRST
                                      DEGREE OF FREEDOM NORMAL TO THE
                                      FLUID-STRUCTURE CONTACT BOUNDARY
                                  2 - LOCAL COORDINATES WITH THE SECOND
                                      DEGREE OF FREEDOM NORMAL TO THE
```

		FLUID-STRUCTURE CONTACT BOUNDARY 3 - LOCAL COORDINATES WITH THE THIRD DEGREE OF FREEDOM NORMAL TO THE FLUID-STRUCTURE CONTACT BOUNDARY AT THIS TIME OPTIONS 1, 2, OR 3 MAY BE USED ONLY FOR RIGHT CIRCULAR CYLINDERS OR SPHERES. MORE LATITUDE IN THESE CHOICES IS ULTIMATELY PLANNED. FOR USAGE WITH STAGS A VALUE OF 0 MUST ALWAYS BE USED AS STAGS CARRIES OUT ITS OWN GLOBAL TO LOCAL TRANSFORMATION. GLOBAL COORDINATES ARE AUTOMATICALLY SET IN THIS PROCESSOR FOR ALL SURFACE OF REVOLUTION FLUID ELEMENTS
JSTART	I	FIRST OF ONE OR MORE FLUID ELEMENTS HAVING THE SAME VALUE OF NDICOS
JSTOP	I	LAST OF ONE OR MORE FLUID ELEMENTS HAVING THE SAME VALUE OF NDICOS
JINC	I	INCREMENT TO BE APPLIED IN ASSIGNING THE VALUE OF NDICOS TO FLUID ELEMENTS IN THE RANGE FROM JSTART TO JSTOP
NUMCON	I	NUMBER OF DATA SETS REQUIRED TO DEFINE THE CONSTRAINTS TO BE APPLIED TO TRANSLATIONAL STRUCTURAL DEGREES OF FREEDOM DUE TO SYMMETRY CONDITIONS. THESE CONSTRAINTS NEED BE APPLIED ONLY TO STRUCTURAL NODES ON THE WET SURFACE
ICON	I	WILL HAVE THE VALUE 1, 2, OR 3 DEPENDING UPON WHETHER THE TRANSLATIONAL CONSTRAINT IS TO BE APPLIED IN THE X, Y, OR Z GLOBAL COORDINATE DIRECTION. ONLY ONE CONSTRAINT IS ALLOWABLE AT A STRUCTURAL NODE AT THIS TIME HOWEVER THIS LIMITATION IS NOT PARTICULARLY RESTRICTIVE. CONSTRAINTS TO THE AUGMENTED MATRICES ARE REQUIRED ONLY IF A FLUID ELEMENT ASSOCIATED WITH A PARTICULAR STRUCTURAL NODE IS ORIENTED SUCH THAT THE UNIT OUTWARD NORMAL VECTOR OF THE FLUID ELEMENT HAS A COMPONENT PERPENDICULAR TO THE SYMMETRY PLANE. FOR EXAMPLE, A QUARTER CYLINDER MODEL WOULD REQUIRE A CIRCUMFERENTIAL CONSTRAINT BUT NOT AN AXIAL ONE
NSTART	I	FIRST OF ONE OR MORE STRUCTURAL NODES HAVING THE SAME VALUE OF ICON
NSTOP	I	LAST OF ONE OR MORE STRUCTURAL NODES HAVING THE SAME VALUE OF ICON
NINC	I	INCREMENT TO BE APPLIED IN ASSIGNING THE VALUE OF ICON TO STRUCTURAL NODES IN THE RANGE FROM NSTART TO NSTOP

```

        PRTPNT        I          A VALUE OF ONE (1) WILL PRODUCE A DISPLAY
                                 OF THE DIAGONAL LOCATION POINTERS OF THE
                                 SKYLINED STRUCTURAL STIFFNESS MATRIX,
                                 OTHERWISE SET TO ZERO UNDER NORMAL
                                 CONDITIONS

        PRTVAL        I          A VALUE OF ONE (1) WILL PRODUCE A DISPLAY
                                 OF THE SKYLINED STIFFNESS MATRIX,
                                 OTHERWISE SET TO ZERO AND ONLY THE
                                 DIAGONAL TERMS WILL BE PRINTED BY DEFAULT.
                                 USE A NON-ZERO VALUE ONLY FOR DIAGNOSTIC
                                 REASONS OR FOR VERY SMALL PROBLEMS AS THE
                                 AMOUNT OF OUTPUT CAN BE ENORMOUS

        MAPVAL        I          A VALUE OF ONE (1) WILL PRODUCE A MAP-TYPE
                                 DISPLAY OF MATRIX VALUES TO SHOW THE
                                 CONNECTIVITY ALONE, OTHERWISE SET TO ZERO
                                 UNDER NORMAL CONDITIONS

        MVR1          I          INDEX OF FIRST MATRIX VALUE RECORD TO BE
                                 DISPLAYED. UNDER NORMAL CONDITIONS USE A
                                 VALUE OF ZERO AND THE CODE WILL START THE
                                 DISPLAY AT THE BEGINNING OF THE MATRIX.
                                 USE A NON-ZERO VALUE ONLY WHEN A SPECIFIC
                                 SET OF BLOCKS IS TO BE PRINTED FOR SOME
                                 DIAGNOSTIC REASON

        MVR2          I          INDEX OF LAST MATRIX VALUE RECORD TO BE
                                 DISPLAYED. UNDER NORMAL CONDITIONS USE A
                                 VALUE OF ZERO AND THE CODE WILL DISPLAY TO
                                 THE END OF THE MATRIX. USE A NON-ZERO
                                 VALUE ONLY WHEN A SPECIFIC SET OF BLOCKS
                                 IS TO BE PRINTED FOR SOME DIAGNOSTIC
                                 REASON

    * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                I N P U T     D A T A     C A R D     D E C K

    * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

        ALL INPUT DATA EXCEPT ALPHANUMERIC DATA MUST BE RIGHT JUSTIFIED
        IN EIGHT (8) COLUMN FIELDS WHICH CAN OCCUPY THE ENTIRE CARD
        ALPHANUMERIC DATA MUST BE LEFT JUSTIFIED IN TWENTY (20) COLUMN
        FIELDS. FILE NAME PLUS QUALIFIER IS CURRENTLY RESTRICTED TO
        EIGHTEEN (18) CHARACTERS FOR UNIVAC OPERATION WHILE NINETEEN (19)
        CHARACTERS MAY BE USED FOR CDC OPERATION

        GENERAL PROBLEM DEFINITION (MAIN PROGRAM PREPROC):
        --------------------------------------------------

        72 COLUMN ALPHANUMERIC TITLE
        STRNAM              FLUNAM              GEONAM              PRENAM
        FRWTST  SYMCON  PRTAUG
        PRTGMT  PRTTRN  PRTSTF
        DAA2
        NSTR    NSFR    NFRE    NFTR
```

```
MXWD

IF PRTSTF = .TRUE. INCLUDE THE FOLLOWING CARD

NUMBLK  NWDBLK

IF THE FLUID MODEL CONSISTS OF ONLY SURFACE OF REVOLUTION ELEMENTS
SKIP THE FOLLOWING SET OF CARDS

NSETLC
NDICOS  JSTART  JSTOP   JINC      )
   .       .      .       .       )   TOTAL = NSETLC
   .       .      .       .       )

SET SYMMETRY CONSTRAINTS (SUBROUTINE CONSTR):
---------------------------------------------

IF SYMCON = .TRUE. INCLUDE THE FOLLOWING CARDS

NUMCON
ICON    NSTART  NSTOP   NINC      )
   .       .      .       .       )   TOTAL = NUMCON
   .       .      .       .       )

DISPLAY SKYLINED STRUCTURAL STIFFNESS MATRIX (SUBROUTINE STFMAT):
-----------------------------------------------------------------

IF PRTSTF = .TRUE. INCLUDE THE FOLLOWING CARDS

PRTPNT  PRTVAL  MAPVAL
MVR1    MVR2
```

The following discussion is provided as an aid to user understanding of the sample output that is included here.

After a summary of the fluid mesh geometry arrays (see Appendix C) the first item needing explanation is that entitled "Fluid Element Wetted Freedom Indicator". This is simply a listing of the input variable NDICOS (see user manual) for each fluid element.

The section "Structural Grid Point Numbers Associated With Internal Sequence Numbers" contains a correspondence table that relates the internal sequence numbers assigned by the fluid mass processor with the external structural node number assigned by the user.

The next item entitled "Grid Point and Freedom Number for Each Row of Stiffness Matrix" identifies an integer vector that is constructed during the STAGS1 preprocessing. For each structural equation the entry in the vector consists of ten times the structural node number plus the local degree of freedom number.

The last item requiring explanation is the "Freedom/Equation Correspondence Table". This is an integer matrix of 6 rows and as many columns as there are structural node points. Any particular row corresponds to a local degree of freedom number while a column corresponds to the <u>internal</u> sequence number for a particular external node number. The matrix entry for any particular set of row and column is the structural equation number for that pair.

Depending upon user input the various fluid matrices may then be displayed. The matrix called TMIT corresponds to $\underset{\sim}{D}_s$ [see Eq. (2.6)], while DFDS denotes the sum of $\underset{\sim}{D}_s$ and $\underset{\sim}{D}_{f1}$ [see Eq. (2.6)]. In DAA_2 runs $\underset{\sim}{D}_{f1}$ is labeled DAA1 while $\underset{\sim}{D}_{f2}$ is labeled DAA2.

The following input and output for the infinite circular cylindrical shell problem contain some minor differences due to the fact that the input is appropriate to the standard CDC or UNIVAC USA-STAGS version 3 whereas the output is from the VAX virtual memory machine. The basic reason for this is that the VAX version does not explicitly process the fluid equation system in a multi-block, out-of-core mode in contrast to the CDC and UNIVAC versions. In addition, permanent file naming conventions differ slightly; however it is anticipated that these differences should not prove to be a difficulty for the user.

```
AUGMAT RUN FOR INFINITE CYLINDER SIMULATION
STG*CYLMAS          CYL*DAAM               CYL*GEOM               CYL*PREP
          T       F       F
          T       T       F
         O.
         72     432       6       3
        448
          1
          0       1      36       1
```

```
AUGMAT RUN FOR INFINITE CYLINDER SIMULATION


USER OPTIONS FOR THIS RUN:

FRWTGE      FRWTST      FRWTFL
  F           T           F

FLUSKY      DAAFRM      SYMCOM
  F           F           F

PRTGMT      PRTTRN      PRTSTF
  T           T           F

THIS IS A DAA1 RUN

+++  OPEN,  14 = CYL.GEO                , Acc= DIRECT , Stat= OLD

  FLUID MASS DENSITY =   0.10000000E+01

  FLUID SOUND SPEED  =   0.10000000E+01


   2628 WORDS OF STORAGE REQUIRED FOR THIS RUN

+++  OPEN,  16 = CYL.PRE                 Acc= DIRECT , Stat= NEW

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E             +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                    +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc   Next  Limit      Read Written +
+ 12 CYL.GEO     14  1 AX   64     19  10000 100000      763        0 +
+ 14 CYL.PRE     16  1 UPR  64      4      0 100000        0        0 +
+                                                                    +
+                   2 Active devices ( 0 full)                       +
+     0 Tp ops,     0 Writes,     13 Reads          763 Words XFD    +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE, 14

  FLUID MESH GEOMETRIC ARRAYS:

     N    NTRA         X              Y              Z              NX             NY             NZ            A00

     1       2  0.10000000E+01  0.00000000E+00  0.00000000E+00  0.10000000E+01  0.00000000E+00  0.00000000E+00  0.30504508E-01
     2       2  0.98480773E+00  0.17364818E+00  0.00000000E+00  0.98480773E+00  0.17364818E+00  0.00000000E+00  0.30504508E-01
```

3	2	0.93969262E+00	0.34202012E+00	0.00000000E+00	0.93969262E+00	0.34202012E+00	0.00000000E+00	0.30504508E-01
4	2	0.86602539E+00	0.50000000E+00	0.00000000E+00	0.86602539E+00	0.50000000E+00	0.00000000E+00	0.30504508E-01
5	2	0.76604444E+00	0.64278758E+00	0.00000000E+00	0.76604444E+00	0.64278758E+00	0.00000000E+00	0.30504508E-01
6	2	0.64278758E+00	0.76604444E+00	0.00000000E+00	0.64278758E+00	0.76604444E+00	0.00000000E+00	0.30504508E-01
7	2	0.49999997E+00	0.86602545E+00	0.00000000E+00	0.49999997E+00	0.86602545E+00	0.00000000E+00	0.30504508E-01
8	2	0.34202015E+00	0.93969262E+00	0.00000000E+00	0.34202015E+00	0.93969262E+00	0.00000000E+00	0.30504508E-01
9	2	0.17364822E+00	0.98480773E+00	0.00000000E+00	0.17364822E+00	0.98480773E+00	0.00000000E+00	0.30504508E-01
10	2	0.75669959E-07	0.10000000E+01	0.00000000E+00	0.75669959E-07	0.10000000E+01	0.00000000E+00	0.30504508E-01
11	2	-0.17364819E+00	0.98480773E+00	0.00000000E+00	-0.17364819E+00	0.98480773E+00	0.00000000E+00	0.30504508E-01
12	2	-0.34202012E+00	0.93969262E+00	0.00000000E+00	-0.34202012E+00	0.93969262E+00	0.00000000E+00	0.30504508E-01
13	2	-0.50000006E+00	0.86602539E+00	0.00000000E+00	-0.50000006E+00	0.86602539E+00	0.00000000E+00	0.30504508E-01
14	2	-0.64278764E+00	0.76604444E+00	0.00000000E+00	-0.64278764E+00	0.76604444E+00	0.00000000E+00	0.30504508E-01
15	2	-0.76604444E+00	0.64278764E+00	0.00000000E+00	-0.76604444E+00	0.64278764E+00	0.00000000E+00	0.30504508E-01
16	2	-0.86602539E+00	0.50000006E+00	0.00000000E+00	-0.86602539E+00	0.50000006E+00	0.00000000E+00	0.30504508E-01
17	2	-0.93969262E+00	0.34202021E+00	0.00000000E+00	-0.93969262E+00	0.34202021E+00	0.00000000E+00	0.30504508E-01
18	2	-0.98480773E+00	0.17364830E+00	0.00000000E+00	-0.98480773E+00	0.17364830E+00	0.00000000E+00	0.30504508E-01
19	2	-0.10000000E+01	0.15087426E-06	0.00000000E+00	-0.10000000E+01	0.15087426E-06	0.00000000E+00	0.30504508E-01
20	2	-0.98480779E+00	-0.17364800E+00	0.00000000E+00	-0.98480779E+00	-0.17364800E+00	0.00000000E+00	0.30504508E-01
21	2	-0.93969262E+00	-0.34202015E+00	0.00000000E+00	-0.93969262E+00	-0.34202015E+00	0.00000000E+00	0.30504508E-01
22	2	-0.86602539E+00	-0.49999997E+00	0.00000000E+00	-0.86602539E+00	-0.49999997E+00	0.00000000E+00	0.30504508E-01
23	2	-0.76604450E+00	-0.64278758E+00	0.00000000E+00	-0.76604450E+00	-0.64278758E+00	0.00000000E+00	0.30504508E-01
24	2	-0.64278787E+00	-0.76604426E+00	0.00000000E+00	-0.64278787E+00	-0.76604426E+00	0.00000000E+00	0.30504508E-01
25	2	-0.49999991E+00	-0.86602545E+00	0.00000000E+00	-0.49999991E+00	-0.86602545E+00	0.00000000E+00	0.30504508E-01
26	2	-0.34202006E+00	-0.93969262E+00	0.00000000E+00	-0.34202006E+00	-0.93969262E+00	0.00000000E+00	0.30504508E-01
27	2	-0.17364813E+00	-0.98480779E+00	0.00000000E+00	-0.17364813E+00	-0.98480779E+00	0.00000000E+00	0.30504508E-01
28	2	0.11924880E-07	-0.10000000E+01	0.00000000E+00	0.11924880E-07	-0.10000000E+01	0.00000000E+00	0.30504508E-01
29	2	0.17364815E+00	-0.98480773E+00	0.00000000E+00	0.17364815E+00	-0.98480773E+00	0.00000000E+00	0.30504508E-01
30	2	0.34202009E+00	-0.93969262E+00	0.00000000E+00	0.34202009E+00	-0.93969262E+00	0.00000000E+00	0.30504508E-01
31	2	0.49999991E+00	-0.86602545E+00	0.00000000E+00	0.49999991E+00	-0.86602545E+00	0.00000000E+00	0.30504508E-01
32	2	0.64278752E+00	-0.76604450E+00	0.00000000E+00	0.64278752E+00	-0.76604450E+00	0.00000000E+00	0.30504508E-01
33	2	0.76604432E+00	-0.64278775E+00	0.00000000E+00	0.76604432E+00	-0.64278775E+00	0.00000000E+00	0.30504508E-01
34	2	0.86602533E+00	-0.50000018E+00	0.00000000E+00	0.86602533E+00	-0.50000018E+00	0.00000000E+00	0.30504508E-01
35	2	0.93969256E+00	-0.34202036E+00	0.00000000E+00	0.93969256E+00	-0.34202036E+00	0.00000000E+00	0.30504508E-01
36	2	0.98480773E+00	-0.17364845E+00	0.00000000E+00	0.98480773E+00	-0.17364845E+00	0.00000000E+00	0.30504508E-01

LOCAL FLUID-STRUCTURE TRANSFORMATION COEFFICIENTS:

NFLU	NSTR	
1	1	37
	0.50000E+00	0.50000E+00
2	2	38
	0.50000E+00	0.50000E+00
3	3	39
	0.50000E+00	0.50000E+00
4	4	40
	0.50000E+00	0.50000E+00
5	5	41
	0.50000E+00	0.50000E+00
6	6	42
	0.50000E+00	0.50000E+00

```
 7         7          43
      0.50000E+00 0.50000E+00
 8         8          44
      0.50000E+00 0.50000E+00
 9         9          45
      0.50000E+00 0.50000E+00
10        10          46
      0.50000E+00 0.50000E+00
11        11          47
      0.50000E+00 0.50000E+00
12        12          48
      0.50000E+00 0.50000E+00
13        13          49
      0.50000E+00 0.50000E+00
14        14          50
      0.50000E+00 0.50000E+00
15        15          51
      0.50000E+00 0.50000E+00
16        16          52
      0.50000E+00 0.50000E+00
17        17          53
      0.50000E+00 0.50000E+00
18        18          54
      0.50000E+00 0.50000E+00
19        19          55
      0.50000E+00 0.50000E+00
20        20          56
      0.50000E+00 0.50000E+00
21        21          57
      0.50000E+00 0.50000E+00
22        22          58
      0.50000E+00 0.50000E+00
23        23          59
      0.50000E+00 0.50000E+00
24        24          60
      0.50000E+00 0.50000E+00
25        25          61
      0.50000E+00 0.50000E+00
26        26          62
      0.50000E+00 0.50000E+00
27        27          63
      0.50000E+00 0.50000E+00
28        28          64
      0.50000E+00 0.50000E+00
29        29          65
      0.50000E+00 0.50000E+00
30        30          66
      0.50000E+00 0.50000E+00
31        31          67
      0.50000E+00 0.50000E+00
32        32          68
```

```
             0.50000E+00 0.50000E+00
    33           33          69
             0.50000E+00 0.50000E+00
    34           34          70
             0.50000E+00 0.50000E+00
    35           35          71
             0.50000E+00 0.50000E+00
    36           36          72
             0.50000E+00 0.50000E+00

 FLUID ELEMENT WETTED FREEDOM INDICATOR:

             1           2           3           4           5           6           7           8           9          10
             0           0           0           0           0           0           0           0           0           0

            11          12          13          14          15          16          17          18          19          20
             0           0           0           0           0           0           0           0           0           0

            21          22          23          24          25          26          27          28          29          30
             0           0           0           0           0           0           0           0           0           0

            31          32          33          34          35          36
             0           0           0           0           0           0

 GENERALIZED FLUID AREAS:

             1           2           3           4           5           6           7           8           9          10
   0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01
            11          12          13          14          15          16          17          18          19          20
   0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01
            21          22          23          24          25          26          27          28          29          30
   0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01
            31          32          33          34          35          36
   0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01 0.30505E-01
+++  OPEN,    2 = CYL.USD                  , Acc= SEQUENT, Stat= OLD
+++  Form = UNFORMATTED

 DIAGONAL STRUCTURAL MASS MATRIX:

             1           2           3           4           5           6           7           8           9          10
   0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06 0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06
            11          12          13          14          15          16          17          18          19          20
   0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06 0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02
            21          22          23          24          25          26          27          28          29          30
   0.11973E-02 0.58291E-06 0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06 0.57841E-06 0.28534E-06
            31          32          33          34          35          36          37          38          39          40
   0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06 0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06
            41          42          43          44          45          46          47          48          49          50
   0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02 0.11973E-02 0.58291E-06 0.57841E-06 0.28534E-06 0.11973E-02 0.11973E-02
            51          52          53          54          55          56          57          58          59          60
```

0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
61	62	63	64	65	66	67	68	69	70
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
71	72	73	74	75	76	77	78	79	80
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
81	82	83	84	85	86	87	88	89	90
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
91	92	93	94	95	96	97	98	99	100
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
101	102	103	104	105	106	107	108	109	110
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
111	112	113	114	115	116	117	118	119	120
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
121	122	123	124	125	126	127	128	129	130
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
131	132	133	134	135	136	137	138	139	140
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
141	142	143	144	145	146	147	148	149	150
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
151	152	153	154	155	156	157	158	159	160
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
161	162	163	164	165	166	167	168	169	170
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
171	172	173	174	175	176	177	178	179	180
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
181	182	183	184	185	186	187	188	189	190
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
191	192	193	194	195	196	197	198	199	200
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
201	202	203	204	205	206	207	208	209	210
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
211	212	213	214	215	216	217	218	219	220
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
221	222	223	224	225	226	227	228	229	230
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
231	232	233	234	235	236	237	238	239	240
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
241	242	243	244	245	246	247	248	249	250
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
251	252	253	254	255	256	257	258	259	260
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
261	262	263	264	265	266	267	268	269	270
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
271	272	273	274	275	276	277	278	279	280
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
281	282	283	284	285	286	287	288	289	290
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
291	292	293	294	295	296	297	298	299	300
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
301	302	303	304	305	306	307	308	309	310
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06

311	312	313	314	315	316	317	318	319	320
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
321	322	323	324	325	326	327	328	329	330
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
331	332	333	334	335	336	337	338	339	340
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
341	342	343	344	345	346	347	348	349	350
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
351	352	353	354	355	356	357	358	359	360
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
361	362	363	364	365	366	367	368	369	370
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
371	372	373	374	375	376	377	378	379	380
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
381	382	383	384	385	386	387	388	389	390
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
391	392	393	394	395	396	397	398	399	400
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
401	402	403	404	405	406	407	408	409	410
0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02
411	412	413	414	415	416	417	418	419	420
0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06
421	422	423	424	425	426	427	428	429	430
0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06	0.57841E-06	0.28534E-06	0.11973E-02	0.11973E-02	0.11973E-02	0.58291E-06
431	432								
0.57841E-06	0.28534E-06								

STRUCTURAL GRID POINT NUMBERS ASSOCIATED WITH INTERNAL SEQUENCE NUMBERS:

1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
61	62	63	64	65	66	67	68	69	70
71	72								

71	72								

GRID POINT AND FREEDOM NUMBER FOR EACH ROW OF STIFFNESS MATRIX:

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	21	22	23	24
11	12	13	14	15	16	17	18	19	20
25	26	31	32	33	34	35	36	41	42
21	22	23	24	25	26	27	28	29	30
43	44	45	46	51	52	53	54	55	56
31	32	33	34	35	36	37	38	39	40
61	62	63	64	65	66	71	72	73	74
41	42	43	44	45	46	47	48	49	50
75	76	81	82	83	84	85	86	91	92
51	52	53	54	55	56	57	58	59	60
93	94	95	96	101	102	103	104	105	106
61	62	63	64	65	66	67	68	69	70
111	112	113	114	115	116	121	122	123	124
71	72	73	74	75	76	77	78	79	80
125	126	131	132	133	134	135	136	141	142
81	82	83	84	85	86	87	88	89	90
143	144	145	146	151	152	153	154	155	156
91	92	93	94	95	96	97	98	99	100
161	162	163	164	165	166	171	172	173	174
101	102	103	104	105	106	107	108	109	110
175	176	181	182	183	184	185	186	191	192
111	112	113	114	115	116	117	118	119	120
193	194	195	196	201	202	203	204	205	206
121	122	123	124	125	126	127	128	129	130
211	212	213	214	215	216	221	222	223	224
131	132	133	134	135	136	137	138	139	140
225	226	231	232	233	234	235	236	241	242
141	142	143	144	145	146	147	148	149	150
243	244	245	246	251	252	253	254	255	256
151	152	153	154	155	156	157	158	159	160

261	262	263	264	265	266	271	272	273	274
161 275	162 276	163 281	164 282	165 283	166 284	167 285	168 286	169 291	170 292
171 293	172 294	173 295	174 296	175 301	176 302	177 303	178 304	179 305	180 306
181 311	182 312	183 313	184 314	185 315	186 316	187 321	188 322	189 323	190 324
191 325	192 326	193 331	194 332	195 333	196 334	197 335	198 336	199 341	200 342
201 343	202 344	203 345	204 346	205 351	206 352	207 353	208 354	209 355	210 356
211 361	212 362	213 363	214 364	215 365	216 366	217 371	218 372	219 373	220 374
221 375	222 376	223 381	224 382	225 383	226 384	227 385	228 386	229 391	230 392
231 393	232 394	233 395	234 396	235 401	236 402	237 403	238 404	239 405	240 406
241 411	242 412	243 413	244 414	245 415	246 416	247 421	248 422	249 423	250 424
251 425	252 426	253 431	254 432	255 433	256 434	257 435	258 436	259 441	260 442
261 443	262 444	263 445	264 446	265 451	266 452	267 453	268 454	269 455	270 456
271 461	272 462	273 463	274 464	275 465	276 466	277 471	278 472	279 473	280 474
281 475	282 476	283 481	284 482	285 483	286 484	287 485	288 486	289 491	290 492
291 493	292 494	293 495	294 496	295 501	296 502	297 503	298 504	299 505	300 506
301 511	302 512	303 513	304 514	305 515	306 516	307 521	308 522	309 523	310 524
311 525	312 526	313 531	314 532	315 533	316 534	317 535	318 536	319 541	320 542
321	322	323	324	325	326	327	328	329	330

543	544	545	546	551	552	553	554	555	556
331	332	333	334	335	336	337	338	339	340
561	562	563	564	565	566	571	572	573	574
341	342	343	344	345	346	347	348	349	350
575	576	581	582	583	584	585	586	591	592
351	352	353	354	355	356	357	358	359	360
593	594	595	596	601	602	603	604	605	606
361	362	363	364	365	366	367	368	369	370
611	612	613	614	615	616	621	622	623	624
371	372	373	374	375	376	377	378	379	380
625	626	631	632	633	634	635	636	641	642
381	382	383	384	385	386	387	388	389	390
643	644	645	646	651	652	653	654	655	656
391	392	393	394	395	396	397	398	399	400
661	662	663	664	665	666	671	672	673	674
401	402	403	404	405	406	407	408	409	410
675	676	681	682	683	684	685	686	691	692
411	412	413	414	415	416	417	418	419	420
693	694	695	696	701	702	703	704	705	706
421	422	423	424	425	426	427	428	429	430
711	712	713	714	715	716	721	722	723	724
431	432								
725	726								

FREEDOM/EQUATION CORRESPONDENCE TABLE:

	1	2	3	4	5	6	7	8	9	10
1	1	7	13	19	25	31	37	43	49	55
2	2	8	14	20	26	32	38	44	50	56
3	3	9	15	21	27	33	39	45	51	57
4	4	10	16	22	28	34	40	46	52	58
5	5	11	17	23	29	35	41	47	53	59
6	6	12	18	24	30	36	42	48	54	60

	11	12	13	14	15	16	17	18	19	20
1	61	67	73	79	85	91	97	103	109	115
2	62	68	74	80	86	92	98	104	110	116
3	63	69	75	81	87	93	99	105	111	117
4	64	70	76	82	88	94	100	106	112	118

5	65	71	77	83	89	95	101	107	113	119
6	66	72	78	84	90	96	102	108	114	120
	21	22	23	24	25	26	27	28	29	30
1	121	127	133	139	145	151	157	163	169	175
2	122	128	134	140	146	152	158	164	170	176
3	123	129	135	141	147	153	159	165	171	177
4	124	130	136	142	148	154	160	166	172	178
5	125	131	137	143	149	155	161	167	173	179
6	126	132	138	144	150	156	162	168	174	180
	31	32	33	34	35	36	37	38	39	40
1	181	187	193	199	205	211	217	223	229	235
2	182	188	194	200	206	212	218	224	230	236
3	183	189	195	201	207	213	219	225	231	237
4	184	190	196	202	208	214	220	226	232	238
5	185	191	197	203	209	215	221	227	233	239
6	186	192	198	204	210	216	222	228	234	240
	41	42	43	44	45	46	47	48	49	50
1	241	247	253	259	265	271	277	283	289	295
2	242	248	254	260	266	272	278	284	290	236
3	243	249	255	261	267	273	279	285	291	297
4	244	250	256	262	268	274	280	286	292	298
5	245	251	257	263	269	275	281	287	293	299
6	246	252	258	264	270	276	282	288	294	300
	51	52	53	54	55	56	57	58	59	60
1	301	307	313	319	325	331	337	343	349	355
2	302	308	314	320	326	332	338	344	350	356
3	303	309	315	321	327	333	339	345	351	357
4	304	310	316	322	328	334	340	346	352	358
5	305	311	317	323	329	335	341	347	353	359
6	306	312	318	324	330	336	342	348	354	360
	61	62	63	64	65	66	67	68	69	70
1	361	367	373	379	385	391	397	403	409	415
2	362	368	374	380	386	392	398	404	410	416
3	363	369	375	381	387	393	399	405	411	417
4	364	370	376	382	388	394	400	406	412	418
5	365	371	377	383	389	395	401	407	413	419
6	366	372	378	384	390	396	402	408	414	420
	71	72								
1	421	427								
2	422	428								
3	423	429								
4	424	430								
5	425	431								
6	426	432								

```
+++  CLOSE,  2
+++  OPEN,  12 = CYL.FLU                   , Acc= DIRECT , Stat= OLD
+++  CLOSE, 12

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E           +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                    +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc   Next  Limit     Read Written +
+ 14 CYL.PRE      16  1 UPR  64     4      42 100000       73    2469 +
+                                                                    +
+                    1 Active devices ( 0 full)                      +
+     0 Tp ops,      9 Writes,     16 Reads        4601 Words XFD    +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE, 16
```

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SUMMARY OF DATA STORED ON PERMANENT FILE
*** CYL.PRE ***

RECORD	RECORD DESCRIPTION	SECTOR LOCATION	NUMBER OF WORDS
1	FILE LIBRARY DATA	0	253
2	FLUID GEOMETRY AND TRANSFORMATION DATA	4	540
3	GENERALIZED FLUID AREAS	13	36
4	FREEDOM/EQUATION CORRESPONDENCE TABLE	14	432
5	DIAGONAL STRUCTURAL MASS INV	21	432
6	DIAGONAL POINTERS FOR DAA STRUCTURAL MASS INV	28	37
7	SKYLINE ENTRIES FOR DAA STRUCTURAL MASS INV	29	36
8	DIAGONAL POINTERS FOR DAA VIRTUAL MASS INV	30	37
9	SKYLINE ENTRIES FOR DAA VIRTUAL MASS INV	31	666

APPENDIX E

USER INFORMATION FOR THE TIME INTEGRATION PROCESSOR TIMINT

This appendix includes a copy of the users manual, and a sample input deck and subsequent output for the infinite cylindrical shell problem presented in Section 4.

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                         T I M I N T
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     THIS FUNCTIONAL COMPONENT OF THE UNDERWATER SHOCK ANALYSIS CODE
     CONDUCTS A STEP-BY-STEP DIRECT NUMERICAL TIME INTEGRATION OF THE
     GOVERNING EQUATIONS OF SUBMERGED STRUCTURES EXPOSED TO SPHERICAL
     SHOCK WAVES OF ARBITRARY PRESSURE PROFILE AND SOURCE LOCATION. THE
     FLUID EQUATIONS UTILIZE THE WELL-KNOWN DOUBLY ASYMPTOTIC
     APPROXIMATION (DAA) WHILE THE STRUCTURE ITSELF MAY BE TREATED BY A
     VARIETY OF LINEAR OR NONLINEAR PROGRAM MODULES THAT CARRY OUT THE
     SPATIAL ANALYSIS AT EACH TIME STEP. THE CODE USES THE STAGGERED
     SOLUTION PROCEDURE WHEREIN THE STRUCTURAL RESPONSE EQUATIONS AND
     THE FLUID RESPONSE EQUATIONS ARE SOLVED SEPARATELY AT EACH TIME
     STEP THROUGH EXTRAPOLATION OF THE TERMS WHICH COUPLE THE TWO
     SYSTEMS

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

     THIS PROGRAM WAS DEVELOPED AND CODED BY JOHN A. DERUNTZ, JR.
     OF LOCKHEED MISSILES AND SPACE CO. RESEARCH LABS IN PALO ALTO
     CALIFORNIA. PLEASE CONSULT WITH AUTHOR BEFORE MAKING CHANGES
     AND ALSO REPORT ANY MALFUNCTIONS OR PROBLEMS. WRITE IN CARE OF
     LOCKHEED PALO ALTO RESEARCH LABORATORY, BLDG 205, DEPT 52-33,
     3251 HANOVER ST., PALO ALTO, CALIF., 94304 OR CALL 415-493-4411
     EXTS. 45069 OR 45133.
                                                  SEPTEMBER, 1980
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                  M A X I M U M     V A L U E S
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    MAXIMUM NUMBER OF INPUT PRESSURE DATA POINTS:

                  INFINITE FLUID  . . . . . . . . . . . . . . . .    4 0 2

                  FREE SURFACE PROBLEM  . . . . . . . . . . . . .    2 0 1
    MAXIMUM NUMBER OF CUBIC SPLINE TIME POINTS:

                  INFINITE FLUID  . . . . . . . . . . . . . . . .    1 0 2

                  FREE SURFACE PROBLEM  . . . . . . . . . . . . .      5 1
    MAXIMUM NUMBER OF DIFFERENT TIME STEP SIZES . . . . . . . . .      1 0
    MAXIMUM NUMBER OF PREVIOUS RESPONSE FILES . . . . . . . . . .        9
    MAXIMUM NUMBER OF TRANSIENT RESPONSE DISPLAYS . . . . . . . .    1 0 0
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

              R U N     T I M E     I N F O R M A T I O N
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THE FOLLOWING INFORMATION IS PROVIDED FOR THE ESTIMATION OF CPU
TIME IN SECONDS TO WHICH MUST BE ADDED INPUT/OUTPUT CHARGES,
CORE-BLOCK TIME, EXECUTIVE REQUESTS, FILE CHARGES, ETC. THE RULE
TO FOLLOW IS TO ESTIMATE CPU TIME AND THEN INCREASE THIS TO ARRIVE
AT AN APPROXIMATE SYSTEM CHARGE ESTIMATE. FOR SMALL PROBLEMS THE
SYSTEM CHARGES CAN EASILY DOMINATE AND A LARGE FACTOR WOULD HAVE
TO BE APPLIED TO THE RUN TIME COMPUTED BELOW. FOR FAIRLY LARGE
PROBLEMS (2500 DOF) THIS FACTOR DROPS DOWN TO ABOUT TWO (2) FOR
UNIVAC OPERATION

THE ESTIMATES FOR STRUCTURAL FACTORIZATION AND ADVANCEMENT TIMES
GIVEN BELOW DO NOT APPLY TO THE USA-STAGS SYSTEM. PLEASE CONSULT A
STAGS MANUAL

DEFINITION OF VARIABLES REQUIRED FOR RUN TIME COMPUTATION:

    NSTEP     NUMBER OF TIME STEPS

    NTINC     NUMBER OF DIFFERENT TIME STEP INCREMENTS

    NDISP     NUMBER OF DEGREES OF FREEDOM FOR WHICH TRANSIENT
              RESPONSE HISTORIES ARE TO BE DISPLAYED AT CONCLUSION
              OF RUN

    NSFR      NUMBER OF DEGREES OF FREEDOM OF STRUCTURAL SYSTEM

    NFLU      NUMBER OF DEGREES OF FREEDOM OF FLUID SYSTEM

    BAVE      AVERAGE HALF BAND WIDTH OF STRUCTURAL STIFFNESS
              MATRIX

    BRMS      ROOT MEAN SQUARE HALF BAND WIDTH OF STRUCTURAL
              STIFFNESS MATRIX. USE AVERAGE HALF BAND WIDTH IF
              THIS QUANTITY IS NOT READILY AVAILABLE

    TCPU      TOTAL CENTRAL PROCESSING UNIT TIME REQUIRED FOR
              LISTED ITEMS BELOW

              TCPU = TPRE + NTINC*(TFS+TFF) + NSTEP*(TAS+TAF) + TDISP

    TPRE      CPU TIME SPENT ON PRE-PROCESSING BEFORE TIME
              INTEGRATION COMMENCES

              TPRE = 1000.*CS*(NSFR+NFLU)

    TFS       TIME REQUIRED TO FACTOR STRUCTURAL EQUATION SYSTEM

              TFS = CS*NSFR*BRMS**2/2.

    TAS       TIME REQUIRED FOR ADVANCEMENT OF ONE TIME STEP FOR
              STRUCTURAL SYSTEM

              TAS = 3.*CS*NSFR*BAVE

    TFF       TIME REQUIRED TO FACTOR FLUID EQUATION SYSTEM

              TFF = CS*NFLU**3/6.
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     TAF       TIME REQUIRED FOR ADVANCEMENT OF ONE TIME STEP FOR
               FLUID SYSTEM

               TAF = CS*NFLU**2

     TDISP     CPU TIME SPENT ON DISPLAY OF RESPONSE HISTORIES

               TDISP = 500.*CS*NSTEP*NDISP

     CS        UNIT OPERATION CONSTANT IN SECONDS, CONSISTING OF A
               FLOATING ADDITION, A FLOATING MULTIPLY, AND INDEXING

               V A L U E S   O F   C O N S T A N T   C S
               - - - - - -   - -   - - - - - - - -   - -

                             O P E R A T I N G   S Y S T E M

               PRECISION     UNIVAC        UNIVAC        CDC
                              1108          1110         6600

                 SINGLE     5.5X10-6      3.2X10-6     1.5X10-6

                 DOUBLE     9.0X10-6      4.5X10-6       - - -

               AT THIS TIME THE CODE OPERATES ONLY IN SINGLE
               PRECISION

   IN ADDITION TO BILLABLE CHARGES DUE TO EXECUTION OF THIS CODE
   THERE WILL PROBABLY BE A DAILY CHARGE FOR PERMANENT FILE STORAGE.
   RESPONSE AND RESTART FILES CREATED BY THIS CODE CAN BE EXTREMELY
   LENGTHY HENCE SUCH OUTPUT FROM LARGE RUNS SHOULD BE TRANSFERRED TO
   TAPE AT THE EARLIEST OPPORTUNITY TO MINIMIZE THESE CHARGES

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 W A R N I N G    F R O M    T H E    P R O G R A M M E R    G E N E R A L

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   THIS CODE CONTAINS THE SPECIAL INGREDIENT DMGASP NOT FOUND IN
   OTHER BRANDS. DMGASP IS A DATA MANAGEMENT UTILITY MODULE THAT
   WILL ACTIVATE AND DEACTIVATE ALL AUXILIARY STORAGE DATA FILES
   REFERENCED BY THE CODE. HENCE THE NAMES OF SUCH FILES SHOULD NOT
   APPEAR ON ANY CONTROL CARDS IN THE RUN STREAM WHICH MIGHT NORMALLY
   ACTIVATE AND DEACTIVATE THE FILES. THE USER IS ALSO CAUTIONED THAT
   PREVIOUSLY CREATED FILES MUST ALREADY BE RESIDENT IN THE SYSTEM
   BEFORE THE RUN IS INITIATED. IF A FILE HAS BEEN ROLLED-OUT TO TAPE
   DMGASP WILL ATTEMPT TO HAVE THE FILE ROLLED-IN EVERY 15 SECONDS
   FOR UP TO 6 MINUTES ON THE UNIVAC 1100-EXEC 8 OPERATING SYSTEM.
   IF AN EXISTING DATA FILE HAS NOT BEEN REFERENCED FOR SOME TIME IT
   IS THEREFORE GOOD POLICY TO SIMPLY ACTIVATE AND DEACTIVATE THE
   FILE BEFORE EXECUTION OF THIS CODE. IF THE USER ATTEMPTS TO CREATE
   A NEW DATA FILE WITH A NAME WHICH IS ALREADY ASSIGNED TO AN
   EXISTING FILE, THE UNIVAC VERSION OF DMGASP WILL MODIFY THE NAME
   OF THE FILE GENERATED BY THIS RUN TO AVOID ANY CONFLICT. FILE NAME
   DUPLICATION WILL CAUSE NO PROBLEM ON THE CDC SCOPE OPERATING
   SYSTEM AS SCOPE WILL SIMPLY CATALOG A NEW CYCLE OF THE SAME FILE.
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ON THE OTHER HAND THE CDC NOS SYSTEM IS SIMILAR TO UNIVAC IN THIS
REGARD AND THE RUN WILL ABORT SINCE THE NAME-CHANGING FEATURE OF
DMGASP HAS NOT BEEN IMPLEMENTED FOR NOS. QUALIFIER*FILENAME IS THE
REQUIRED INPUT DATA FORMAT FOR ALL UNIVAC PERMANENT FILE NAMES.
ON CDC SCOPE, THE QUALIFIER IS INTERPRETED AS THE USERS ID, WHICH
IN MOST INSTALLATIONS CAN BE SELECTED ALMOST ARBITRARILY. ON CDC
NOS, THE QUALIFIER IS INTERPRETED AS THE USERS CATALOG NUMBER,
WHICH IS USUALLY PRESCRIBED BY THE INSTALLATION. A CYCLE NUMBER
CAN ALSO BE APPENDED TO GIVE THE FORM QUALIFIER*FILENAME(CYCLE)
ON CDC SCOPE

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                    P R O G R A M    S I Z E

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ALL ARRAYS REFERRENCED IN THIS CODE THAT ARE PROBLEM DEPENDENT
RESIDE IN BLANK COMMON. THE SIZE OF BLANK COMMON IS DETERMINED BY
A PARAMETER STATEMENT IN THE MAIN PROGRAM FOR THE UNIVAC 1100-OS
VERSION, HENCE A RECOMPILATION IS NECESSARY TO INCREASE OR
DECREASE CORE ALLOCATION. IN THE CDC 6600 VERSION RECOMPILATION IS
UNNECESSARY AS THE LENGTH OF BLANK COMMON IS SET BY A FIELD LENGTH
REQUEST IN THE CONTROL CARD DECK

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D E F I N I T I O N    O F    I N P U T    P A R A M E T E R S

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INPUT VARIABLE NAMES GIVEN BELOW ARE GENERALLY THOSE WHICH ARE
ALSO USED IN THE CODING AND THE VARIABLE TYPES CORRESPOND TO
STANDARD FORTRAN USAGE:

              A   -   ALPHANUMERIC
              E   -   FLOATING POINT
              F   -   FIXED POINT
              I   -   INTEGER
              L   -   LOGICAL

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VARIABLE    TYPE              DESCRIPTION
--------    ----              -----------

PRENAM       A      NAME OF PRE-PROCESSED MASS STORAGE FILE
                    CONTAINING ALL FLUID AND STRUCTURE DATA
                    THAT DOES NOT DEPEND UPON THE SHOCK INPUT
                    AND TIME INTEGRATION PARAMETERS

POSNAM       A      NAME OF MASS STORAGE FILE AVAILABLE FOR
                    POST-PROCESSING WHICH CONTAINS SYSTEM
                    RESPONSES

STRNEW       A      LEAVE BLANK FOR NORMAL USAGE, OTHERWISE
                    THIS IS THE NAME OF A DIFFERENT STRUCTURAL
                    STIFFNESS MATRIX FILE THAT IS TO BE USED
                    IN THE TIME INTEGRATION RUN RATHER THAN
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		THE ONE USED IN THE AUGMAT PROCESSOR. THE ONLY CONDITIONS UNDER WHICH THIS ABNORMAL CASE CAN BE USED ARE WHEN THE STRUCTURE AND ITS MASS ARE THE SAME AS BEFORE, BUT ITS ELASTIC CONSTANTS ARE DIFFERENT AS OFTEN OCCURS IN PARAMETER STUDIES. IN SUCH CASES AUGMAT NEED NOT BE RERUN
RESNAM	A	NAME OF MASS STORAGE FILE THAT CONTAINS INFORMATION FOR RESTARTING THE TRANSIENT RESPONSE ANALYSIS
WRTNAM	A	NAME OF MASS STORAGE FILE UPON WHICH RESTART DATA IS TO BE WRITTEN. IF LEFT BLANK THEN RESTART DATA WILL BE WPITEN ON THE FILE DENOTED BY RESNAM
XC, YC, ZC	E,F	CARTESIAN COORDINATES OF THE LOCATION OF SPHERICAL CHARGE IN FLUID MESH SYSTEM
SX, SY, SZ	E,F	CARTESIAN COORDINATES OF THE CHARGE STANDOFF POINT IN THE FLUID MESH SYSTEM. THIS IS THE POINT ON THE STRUCTURE THAT IS CLOSEST TO THE CHARGE. THE INTEGRATION PROCESS STARTS AT TIME EQUAL TO ZERO WITH THE SPHERICAL WAVE JUST TOUCHING THE STRUCTURE AT THIS POINT ASSOCIATED WITH THE MINIMUM DISTANCE TO THE CHARGE
EXPWAV	L	TRUE IF THE INCIDENT PRESSURE PULSE IS EXPRESSED IN THE FORM OF AN EXPONENTIALLY DECAYING FUNCTION, OTHERWISE FALSE
SPLINE	L	TRUE IF THE INCIDENT PRESSURE PULSE IS DESCRIBED BY A CUBIC SPLINE FUNCTION. CARE SHOULD ALWAYS BE TAKEN WITH THE CHOICE OF INPUT DATA POINTS SINCE THIS ALGORITH WILL PRODUCE A CONTINUOUS FUNCTION THAT CAN OSCILLATE WILDLY AROUND AREAS OF RAPID CHANGE. IN SUCH CASES IT IS IMPORTANT TO CLUSTER DATA POINTS IN THESE AREAS
JPHIST	I	NUMBER OF INCIDENT PRESSURE HISTORY DATA POINTS. SEE ABOVE FOR MAXIMUM NUMBER ALLOWED BY CORE ALLOCATION
DTHIST	E,F	TIME INTERVAL ASSOCIATED WITH ANY TWO SUCCESSIVE INCIDENT PRESSURE HISTORY DATA POINTS
PNORM	E,F	CONSTANT MULTIPLICATIVE FACTOR TO BE APPLIED TO THE INPUT PRESSURE HISTORY DATA POINTS
HYDPRE	E,F	VALUE OF HYDROSTATIC PRESSURE ACTING ON SUBMERGED STRUCTURE BEFORE SHOCK WAVE EXCITATION. THIS VARIABLE IS READ FOR USA-STAGS RUNS ONLY. IN THIS CASE A

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                                 STATIC ANALYSIS MUST FIPST BF  ERFORMED
                                 WITH STAGS TO CREATE A RES'' ' 'ILE
                                 CONTAINING THE DEFORMEC          INITIAL
                                 STRESS STA'  THEN THE   .N.IENT ANAL::TS
                                 IS CARRIEL  UT PY RESTARTING STAGS (RLFER
                                 TO STAGS MANUAL ..R RESTART DETAILS)

PHIST            E,F             INCIDENT PRESSURE HISTORY DATA POINTS. THE
                                 VALUES USED IN THE TIME INTEGRATION
                                 PROCESS ARE THE PRODUCT OF PHIST AND PNORM
                                 TO ALLOW FOR THE POSSIBILITY THAT THE
                                 INPUT DATA MAY HAVE BEEN EXPERIMENTALLY
                                 OBTAINED AT A POINT WHICH IS NOT EQUAL TO
                                 SC ABOVE. PNORM MUST THEREFORE REFLECT THE
                                 1/R SCALING DIFFERENCE BETWEEN SC AND THE
                                 LOCATION OF THE PRESSURE SENSOR DURING THE
                                 PULSE CHARACTERIZATION EXPERIMENT. IF THE
                                 INCIDENT PRESSURE GOES TO ZERO AT SOME
                                 POINT AND REMAINS THERE THEN DATA NEED
                                 ONLY BE PROVIDED FOR THAT TIME SPAN AND
                                 THE CODE WILL AUTOMATICALLY ENSURE THAT
                                 THE INCIDENT PRESSURE REMAINS ZERO
                                 THEREAFTER. WHEN RESTARTING THE TRANSIENT
                                 ANALYSIS THE REQUIRED INCIDENT PRESSURE
                                 DATA IS IDENTICAL TO THAT USED IN THE
                                 INITIAL RUN. IF SPLINE IS FALSE THEN THE
                                 PRESSURE HISTORY DATA MUST BE EQUALLY
                                 SPACED IN TIME WITH THE INCREMENT DTHIST.
                                 IF SPLINE IS TRUE THE PRESSURE HISTORY
                                 DATA CAN BE UNEQUALLY SPACED ACCORDING TO
                                 DATA PROVIDED IN TIMES (SEE BELOW). WHEN
                                 USING THE SPLINE CAPABILITY THE LAST
                                 PRESSURE DATA POINT MUST BE ZERO SO THAT
                                 THE CODE CAN AUTOMATICALLY GENERATE ZERO
                                 PRESSURES BEYOND THAT POINT. OTHERWISE AN
                                 OUT-OF-RANGE ERROR EXIT WILL BE TAKEN

PZERO            E,F             PEAK VALUE OF PRESSURE FOR EXPONENTIALLY
                                 DECAYING INCIDENT PULSE

DECAY            E,F             DECAY TIME FOR EXPONENTIALLY DECAYING
                                 INCIDENT PRESSURE PULSE. THIS IS THE TIME
                                 IT TAKES FOR THE PRESSURE TO DROP TO 1/E
                                 (ABOUT .36788) OF ITS PEAK VALUE

TIMES            E,F             TIME VALUES ASSOCIATED WITH UNEQUALLY
                                 SPACED INCIDENT PRESSURE HISTORY VALUES

NTINT            I               NUMBER OF TIME STEP SIZES TO BE USED IN
                                 THE INTEGRATION PROCESS. SEE ABOVE FOR
                                 MAXIMUM NUMBER ALLOWED BY CORE ALLOCATION

STRTIM           E,F             THE STARTING TIME AT WHICH ANY PARTICULAR
                                 STEP SIZE IS TO BE USED UNTIL IT IS EITHER
                                 SUPERCEEDED BY ANOTHER STEP SIZE OR, THE
                                 ENTIRE TRANSIENT ANALYSIS HAS BEEN
                                 COMPLETED
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DELTIM	E,F	TIME STEP SIZE ASSOCIATED WITH STRTIM ABOVE
FINTIM	E,F	TIME AT WHICH THE PRESENT ANALYSIS IS TO BE TERMINATED
NSAVER	I	FREQUENCY OF SAVING SYSTEM RESPONSES ON PERMANENT FILE POSNAM. NSAVER EXPRESSED IN NUMBER OF TIME STEPS
NRESET	I	FREQUENCY OF SAVING RESTART INFORMATION ON PERMANENT FILE RESNAM OR WRTNAM. NRESET IS EXPRESSED IN NUMBER OF TIME STEPS
LOCBEG	I	LOCATION IN POSNAM FILE WHERE RESPONSES FROM CURRENT RUN ARE TO BE PLACED. THIS LOCATION IS MEASURED EITHER IN SECTORS (28 WORDS) ON UNIVAC SYSTEMS OR PHYSICAL RECORD UNITS (PRU OF 64 WORDS) ON CDC HARDWARE. A ZERO VALUE IS THE DESIGNATION OF THE BEGINNING OF THE FILE FOR EITHER SYSTEM IN THIS CODE. IF LOCBEG = 0, A NEW PERMANENT FILE IS ASSIGNED FOR THE RUN WITH THE NAME DENOTED BY POSNAM, OTHERWISE POSNAM IS TAKEN TO BE AN EXISTING FILE. UNDER RESTART CONDITIONS THE APPROPRIATE VALUE OF LOCBEG IS ASCERTAINED FROM OUTPUT GENERATED DURING PRECEEDING RUNS
LOCRES	I	LOCATION IN PERMANENT FILE RESNAM WHERE RESTART DATA IS TO BE FOUND. SEE LOCBEG FOR DEFINITION OF LOCATION. SET EQUAL TO ZERO IF CURRENT RUN IS NOT A RESTART, OTHERWISE APPROPRIATE VALUE OF LOCRES IS ASCERTAINED FROM OUTPUT GENERATED DURING PRECEEDING RUNS
LOCWRT	I	LOCATION IN PERMANENT FILE RESNAM OR WRTNAM WHERE NEW RESTART DATA GENERATED IN THE CURRENT RUN IS TO BE WRITTEN. SEE LOCBEG FOR DEFINITION OF LOCATION. IF WRTNAM HAS BEEN LEFT BLANK (SEE ABOVE) THE RESTART DATA IS WRITTEN ON THE SAME FILE AS THAT CONTAINING THE DATA USED TO RESTART THE CURRENT RUN. IN SUCH A CASE IT IS IMPORTANT THAT LOCWRT BE CAREFULLY CHOSEN SO THAT PREVIOUS DATA IS NOT INADVERTENTLY OVERWRITTEN. AN APPROPRIATE VALUE CAN BE FOUND FROM OUTPUT GENERATED FROM PRECEEDING RUNS. IF LOCWRT = ZERO, A NEW PERMANENT FILE IS ASSIGNED FOR THE RUN WITH THE NAME DENOTED BY WRTNAM, OTHERWISE WRTNAM IS TAKEN TO BE AN EXISTING FILE
FORWRT	L	TRUE IF PERMANENT FILE DENOTED BY POSNAM IS TO BE CREATED USING UNFORMATTED FORTRAN WRITE. OTHERWISE FILE WILL BE CREATED BY DIRECT TRANSFER USING THE DATA MANAGEMENT

SYSTEM DMGASP

DISPLA	L	TRUE IF SELECTED TRANSIENT RESPONSE HISTORIES ARE TO BE DISPLAYED. OTHERWISE FALSE
NPREVT	I	NUMBER OF TIME STEPS PREVIOUSLY COMPUTED WITH RESPONSES SAVED IN PERMANENT FILE DENOTED BY POSNAM. NPREVT WILL BE NONZERO ONLY FOR RESTART RUNS BUT IT CAN BE ZERO UNDER RESTART CONDITIONS IF POSNAM DENOTES A NEW RESPONSE FILE. THE USE OF NPREVT ENSURES THAT ANY TRANSIENT RESPONSE DISPLAY MADE IN CONJUNCTION WITH THE TIME INTEGRATION RUN WILL INCLUDE THE ENTIRE HISTORY AVAILABLE FROM THAT FILE AND NOT JUST THE PORTION COMPUTED DURING THE CURRENT RUN. IF POSNAM CONTAINS THE COMPLETE TRANSIENT SOLUTION BACK TO TIME ZERO THEN NPREVT MUST BE THE NUMBER OF TIME STEPS PLUS ONE TO ACCOUNT FOR THE FACT THAT THE INITIAL CONDITIONS APPEAR IN THE FIRST RECORD. IF THIS RUN IS THE VERY FIRST OF A PARTICULAR SHOCK ANALYSIS THEN NPREVT WILL BE ZERO
NPREVF	I	NUMBER OF RESPONSE FILES FROM PREVIOUS RUNS THAT MAKE UP THE DESIRED TRANSIENT ANALYSIS DISPLAY. DO NOT ADD IN THE CURRENT RUN AS THIS IS DONE BY THE CODE. NPREVF PRESENTLY CANNOT EXCEED NINE (9)
NTIMES	I	THE NUMBER OF RESPONSE RECORDS THAT ARE STORED IN ANY PARTICULAR RESPONSE FILE. THESE MUST BE ORDERED CHRONOLOGICALLY FOR INPUT. NTIMES WILL GENERALLY BE THE NUMBER OF TIME STEPS MADE DURING THE TIME THE FILE WAS CREATED EXCEPT IF THE FILE GOES BACK TO TIME EQUAL TO ZERO. IN THIS CASE NTIMES IS EQUAL TO THE NUMBER OF TIME STEPS PLUS ONE TO ACCOUNT FOR THE FIRST RECORD THAT CONTAINS THE INITIAL CONDITIONS
XVPNAM	A	NAMES OF PREVIOUS RESPONSE FILES THAT MAKE UP A CONTINUOUS SET OF TRANSIENT DATA, ORDERED CHRONOLOGICALLY. DO NOT INCLUDE POSNAM IN THIS LIST
LISTRE	L	TRUE IF TRANSIENT RESPONSE HISTORIES ARE TO BE LISTED IN TABULAR FORM, OTHERWISE FALSE
PRTPLT	L	TRUE IF PRINTER PLOTS ARE TO BE GENERATED FOR TRANSIENT RESPONSE HISTORIES. OTHERWISE FALSE

NWETHS	I	NUMBER OF STRUCTURAL HISTORIES (EITHER DISPLACEMENTS OR VELOCITIES) TO BE DISPLAYED FOR WHICH THE APPROPRIATE STRUCTURAL FREEDOMS CAN BE IDENTIFIED INTERNALLY THROUGH THE FREEDOM/EQUATION CORRESPONDENCE TABLE. ALL STRUCTURAL NODES WHICH PARTICIPATE IN THE FLUID-STRUCTURE TRANSFORMATION WILL FALL INTO THIS CATEGORY AS WELL AS ANY OTHERS WHOSE GRID POINT COORDIATES WERE ENTERED AS DATA FOR THE FLUID MASS PROCESSOR
NDRYHS	I	NUMBER OF STRUCTURAL HISTORIES (EITHER DISPLACEMENTS OR VELOCITIES) TO BE DISPLAYED FOR WHICH THE APPROPRIATE STRUCTURAL FREEDOMS CANNOT BE IDENTIFIED INTERNALLY THROUGH THE FREEDOM/EQUATION CORRESPONDENCE TABLE. DRY STRUCTURE NODE POINTS CAN FALL INTO THIS CATEGORY IF THE USER DID NOT INCLUDE THEM IN THE DATA STREAM FOR THE FLUID MASS PROCESSOR. IN THIS CASE ONE MUST IDENTIFY THE INTERNAL SEQUENCE NUMBER APPROPRIATE TO THE DESIRED DEGREE OF FREEDOM BY A MYSTICAL PROCESS WHICH INVOLVES THE INTIMATE KNOWLEDGE OF THE ELIMINATION ORDER AND ANY REDUCTION OF THE NUMBER OF ACTIVE FREEDOMS DUE TO THE APPLICATION OF CONSTRAINTS. MORAL OF THE STORY - RUN ALL STRUCTURAL GRID POINTS THROUGH THE FLUID MASS PROCESSOR EVEN IF THEY NEVER GET WET
NUMSET	I	NUMBER OF DATA SETS USED TO DEFINE RESPONSE DISPLAYS FOR SEVERAL DEGREES OF FREEDOM THAT DIFFER BY A CONSTANT INCREMENT. THIS FEATURE CAN BE USED TO SIMPLIFY INPUT DATA TO SHOW A NUMBER OF TRANSIENT RESULTS AT DIFFERENT PLACES ALONG A GENERATOR OF A CYLINDER OR, AROUND THE CIRCUMFERENCE AT ANY AXIAL STATION
NODOUT	I	EXTERNAL INDENTIFICATION NUMBER OF STRUCTURAL NODE FOR WHICH A TIME HISTORY DISPLAY IS DESIRED
NFROUT	I	STRUCTURAL DEGREE OF FREEDOM NUMBER FOR WHICH A TIME HISTORY DISPLAY IS DESIRED
NEQHST	I	INTERNAL SEQUENCE NUMBER DETERMINED BY HAND FOR STRUCTURAL DEGREES OF FREEDOM WHICH ARE TO BE DISPLAYED AND ARE NOT INCLUDED IN THE FREEDOM/EQUATION CORRESPONDENCE TABLE FOR REASONS KNOWN ONLY TO THE USER
NODFIR	I	FIRST OF SEVERAL EQUALLY INCREMENTED NODE NUMBERS AT WHICH OUTPUT IS DESIRED

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NODLAS      I       LAST OF SEVERAL EQUALLY INCREMENTED NODE
                    NUMBERS AT WHICH OUTPUT IS DESIRED

NODINC      I       INCREMENT TO BE APPLIED IN ASSIGNING NODE
                    NUMBERS FOR OUTPUT


NPREHS      I       NUMBER OF FLUID PRESSURE HISTORIES TO BE
                    DISPLAYED

NEQHPR      I       FLUID CONTROL POINT NUMBER FOR WHICH A
                    TIME HISTORY DISPLAY IS DESIRED FOR THE
                    TOTAL PRESSURE

SCALEF      L       TRUE IF MULTIPLICATIVE CONSTANT FACTORS
                    ARE TO BE APPLIED TO THE DISPLAYED VALUES
                    OF THE STRUCTURAL DISPLACEMENTS AND
                    VELOCITIES, TOTAL FLUID PRESSURES AND/OR
                    TIME, OTHERWISE FALSE. SUCH FACTORS ARE
                    NOT APPLIED TO THE PERMANENT FILES
                    CONTAINING THE RESPONSE HISTORIES

RESFAC      E,F     MULTIPLICATIVE LENGTH CONVERSION FACTOR TO
                    BE APPLIED TO THE DISPLAYED VALUES OF THE
                    STRUCTURAL DISPLACEMENT AND VELOCITY
                    HISTORIES

PREFAC      E,F     MULTIPLICATIVE PRESSURE CONVERSION FACTOR
                    TO BE APPLIED TO THE DISPLAYED VALUES OF
                    THE TOTAL PRESSURE HISTORIES

TIMFAC      E,F     MULTIPLICATIVE TIME CONVERSION FACTOR TO
                    BE APPLIED TO THE DISPLAYED VALUES OF THE
                    TIME AXIS FOR ALL THE TRANSIENT RESPONSE
                    HISTORIES

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

            I N P U T     D A T A     C A R D     D E C K

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      ALL INPUT DATA EXCEPT ALPHANUMERIC DATA MUST BE RIGHT JUSTIFIED
      IN EIGHT (8) COLUMN FIELDS WHICH CAN OCCUPY THE ENTIRE CARD.
      ALPHANUMERIC DATA MUST BE LEFT JUSTIFIED IN TWENTY (20) COLUMN
      FIELDS. FILE NAME PLUS QUALIFIER IS CURRENTLY RESTRICTED TO
      EIGHTEEN (18) CHARACTERS FOR UNIVAC OPERATION WHILE NINETEEN (19)
      CHARACTERS MAY BE USED FOR CDC OPERATION

      GENERAL PROBLEM DEFINITION (SUBROUTINE INPDAT):
      -----------------------------------------------

      72 COLUMN ALPHNUMERIC TITLE
      PRENAM              POSNAM              STRNEW
      RESNAM              WRTNAM
      XC       YC       ZC
      SX       SY       SZ
      EXPWAV   SPLINE
```

```
JPHIST
PNORM   HYDPRE

IF SPLINE = .FALSE. READ THE FOLLOWING CARD

DTHIST

IF EXPWAV = .FALSE. READ THE FOLLOWING CARDS

PHIST(I), I=1,JPHIST

IF EXPWAV = .TRUE. READ THE FOLLOWING CARD

PZERO   DECAY

CUBIC SPLINE INCIDENT PRESSURE HISTORY DATA (SUBROUTINE CSPRES):
----------------------------------------------------------------

IF SPLINE = .TRUE. READ THE FOLLOWING CARDS

TIMES(I), I-1,JPHIST
PHIST(I), I=1,JPHIST

GENERAL PROBLEM DEFINITION (SUBROUTINE INPDAT):
-----------------------------------------------

NTINT
STRTIM  DELTIM           )
   .       .             )   TOTAL = NTINT
   .       .             )
FINTM
NSAVER  NRESET
LOCBEG  LOCRES  LOCWRT
FORWRT

POST PROCESSING (SUBROUTINE POSTRE):
------------------------------------

DISPLA

IF DISPLA = .FALSE. THIS TERMINATES THE INPUT DATA DECK

NPREVT  NPREVF

IF NPREVF NOT = 0 READ THE FOLLOWING CARDS

NTIMES(I), I=1,NPREVF
XVFNAM(I), I=1,NPREVF

POST PROCESSING (SUBROUTINE RESDSP):
------------------------------------

LISTRE  PRTPLT

POST PROCESSING (SUBROUTINE STRDSP):
------------------------------------

NWETHS  NDRYHS  NUMSET
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```
NODOUT  NFROUT             )                   )
  .       .                )   TOTAL = NWETHS  )
  .       .                )                   )
NODOUT  NFROUT  NEQHST     )                   )  THIS SET FOR
  .       .       .        )   TOTAL = NDRYHS  )
  .       .       .        )                   )  DISPLACEMENTS
                                               )
IF NUMSET = 0 OMIT THE FOLLOWING CARD          )
                                               )
NFROUT  NODFIR  NODLAS  NODINC                 )

NWETHS  NDRYHS  NUMSET                         )
NODOUT  NFROUT             )                   )
  .       .                )   TOTAL = NWETHS  )
  .       .                )                   )
NODOUT  NFROUT  NEQHST     )                   )  THIS SET FOR
  .       .       .        )   TOTAL = NDRYHS  )
  .               .        )                   )  VELOCITIES
                                               )
IF NUMSET = 0 OMIT THE FOLLOWING CARD          )
                                               )
NFROUT  NODFIR  NODLAS  NODINC                 )

POST PROCESSING (SUBROUTINE RESDSP):
------------------------------------

NPREHS  NUMSET
NEQHPR                     )
  .                        )   TOTAL = NPREHS
  .                        )

IF NUMSET = 0 OMIT THE FOLLOWING CARD

NODFIR  NODLAS  NODINC

POST PROCESSING (SUBROUTINE FILBUF):
------------------------------------

SCALEF

IF SCALEF = .TRUE. READ THE FOLLOWING CARD

RESFAC  PREFAC  TIMFAC
```

The following discussion is provided as an aid to user understanding of the sample output that is included here.

First, the amount of storage required for the run given in the output refers solely to the blank common that is set in the main program, USAS. An error exit is taken if insufficient storage is available and the user must see that more is provided either by a recompilation on UNIVAC 1100-OS or by a field length request on CDC.

Sector address information for the response and restart files that is listed at various places in the output is extremely important for subsequent restart runs.

The next item needing discussion is the transient response tabular listings. The desired responses are displayed in matrix form so that each row contains the entire history of a particular degree of freedom except for the first row which is time. Each column therefore contains the instantaneous values of the complete set of response variables desired at a particular time. Each row is identified by the structural or fluid node and its degree of freedom. The letters D, V, and P stand for displacement, velocity and pressure, respectively.

Although printer plots of the transient response results can be displayed as part of the run such output has been deferred to the post-processing phase in Appendix F for this sample problem.

The following input and output for the infinite circular cylindrical shell problem contain some minor differences due to the fact that the input is appropriate to the standard CDC or UNIVAC USA-STAGS version 3 whereas the output is from the VAX virtual memory machine. The basic reason for this is that the VAX version does not explicitly process the fluid equation system in a multi-block, out-of-core mode in contrast to the CDC and UNIVAC versions. In addition, permanent file naming conventions differ slightly; however it is anticipated that these differences should not prove to be a difficulty for the user.

```
STAGS1 PREPROCESSING FOR USA-STAGS RUNS. FULL CYLINDER
 6 0 0 0 1 -1 $ B-1
 1 0 0 1 $ B-2
 1 0 1$ E-3
 1.
 0.
 0 100 0 2
 0. 1000. .05 .1
 0 1
 2 37 $ F-1
 1 4 1 2 $ G-1   CLOSED SHELL CONDITION
 1 0 $ I-1
 98.125 .3 0. 7.85 $ I-2
 1 1 1 $ K-1
 1 .01
 5 4
 0. .1750     0. 360. 1.
 0. 0. 0.
 0. 90. 0.
 1 0 0. 0. 1 $ M-5
 410
 4 6 4 3$ P-1 BOUNDARY CONDITIONS
 0
 0
```

```
TIMINT RUN FOR INFINITE CYLINDER SIMULATION
CYL*PREP            CYL*POST
CYL*REST
  10000.      0.       0.
     1.       0.       0.
     F        F
     2
     1.
    50.
     1.       1.
     1
     0.     .025
   .25
     1       30
     0        0        0
     F
     T
     0        0
     T        F
     2        0
    10        3
    10        2
     4        0
     1        3
    10        3
    10        2
    19        3
     3
     1
    10
    19
     F
```

```
<> CLOCK INITIALIZED ...


CASE TITLE READ FROM STAGS1 FILE
--------------------------------

                ------------------------------------------------
                STAGS1 DATA FOR FULL CYLINDER
                ------------------------------------------------

  14 RECORDS READ FROM FT02
BLANK COMMON BUFFER DIMENSION (NSPACE)
--------------------------------------
   DECIMAL         HEX
    60000          EA60

WORKING SPACE STORAGE ASSIGNMENTS
    NEQ  VMBUFR  PAGESZ   NPAGE  FMBUFR   NWMOD   NWMTX  NSTIFF  NASSEM
    216   11520    1280       9   48235    5003    9534       3       8
```

```
USAS RUN FOR INFINITE CYLINDER SIMULATION

+++ OPEN,  16 = DIRTY:CYL.PRE           , Acc= DIRECT , Stat= OLD

THIS IS A DAA1 RUN

CHARGE LOCATION DATA:

XC =   0.10000000E+05

YC =   0.00000000E+00

ZC =   0.00000000E+00

SC =   0.99990000E+04

PRESSURE HISTORY DATA:   DTHIST =  0.50000000E+02

        1           2
  0.10000E+01 0.10000E+01

TIME STEP DATA:

     N       TS          DT

     1 0.00000E+00 0.25000E-01
     2 0.10000E+01 0.50000E-01
     3 0.20000E+01 0.10000E+00
     4 0.50000E+01

INCIDENT PRESSURE AND PARTICLE VELOCITY:

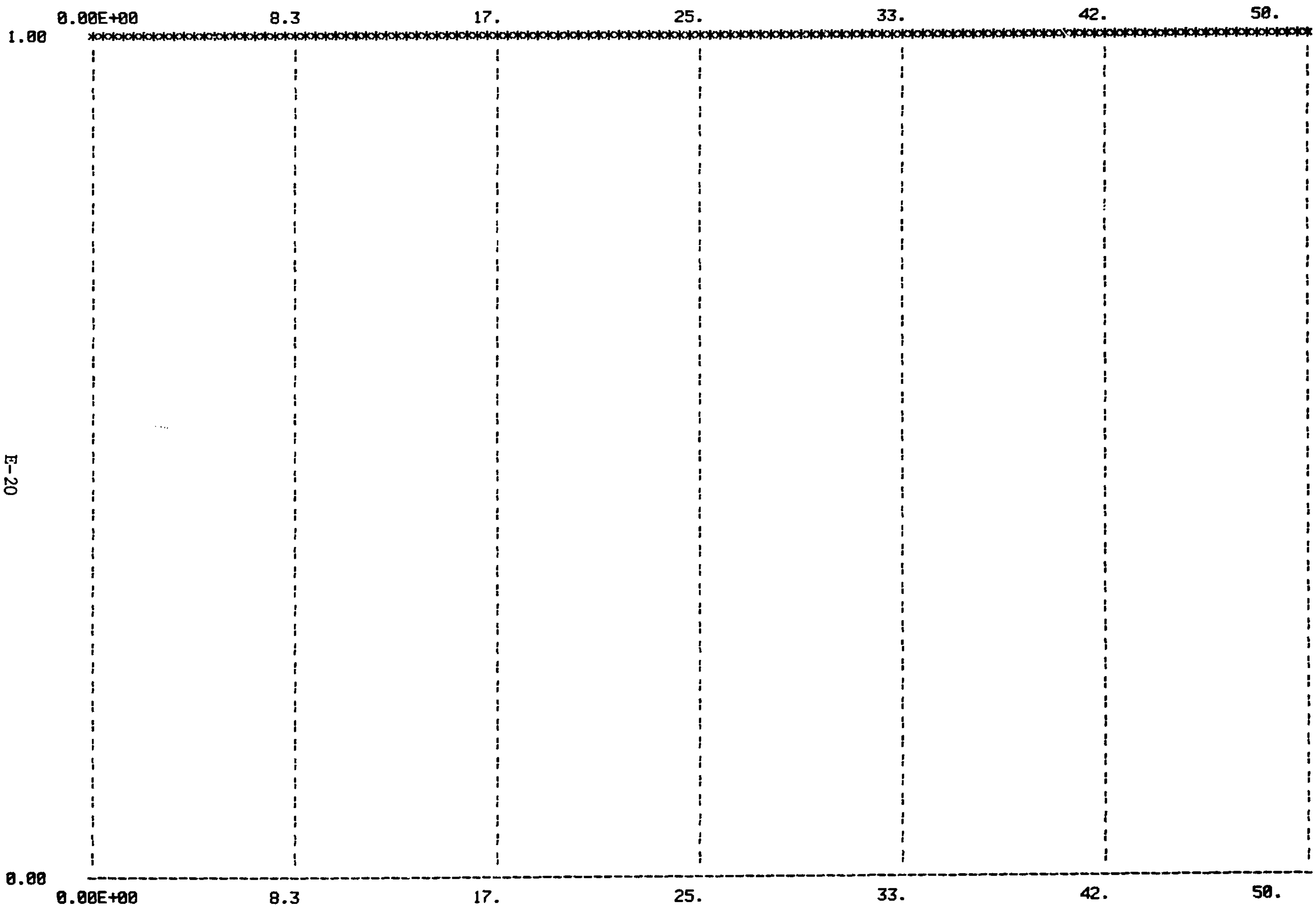
           1           2           3           4           5           6           7           8           9          10
T 0.00000E+00 0.41667E+00 0.83333E+00 0.12500E+01 0.16667E+01 0.20833E+01 0.25000E+01 0.29167E+01 0.33333E+01 0.37500E+01
P 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01
V 0.10000E+01 0.10000E+01 0.10001E+01 0.10001E+01 0.10002E+01 0.10002E+01 0.10002E+01 0.10003E+01 0.10003E+01 0.10004E+01

          11          12          13          14          15          16          17          18          19          20
T 0.41667E+01 0.45833E+01 0.50000E+01 0.54167E+01 0.58333E+01 0.62500E+01 0.66667E+01 0.70833E+01 0.75000E+01 0.79167E+01
P 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01
V 0.10004E+01 0.10005E+01 0.10005E+01 0.10005E+01 0.10006E+01 0.10006E+01 0.10007E+01 0.10007E+01 0.10008E+01 0.10008E+01

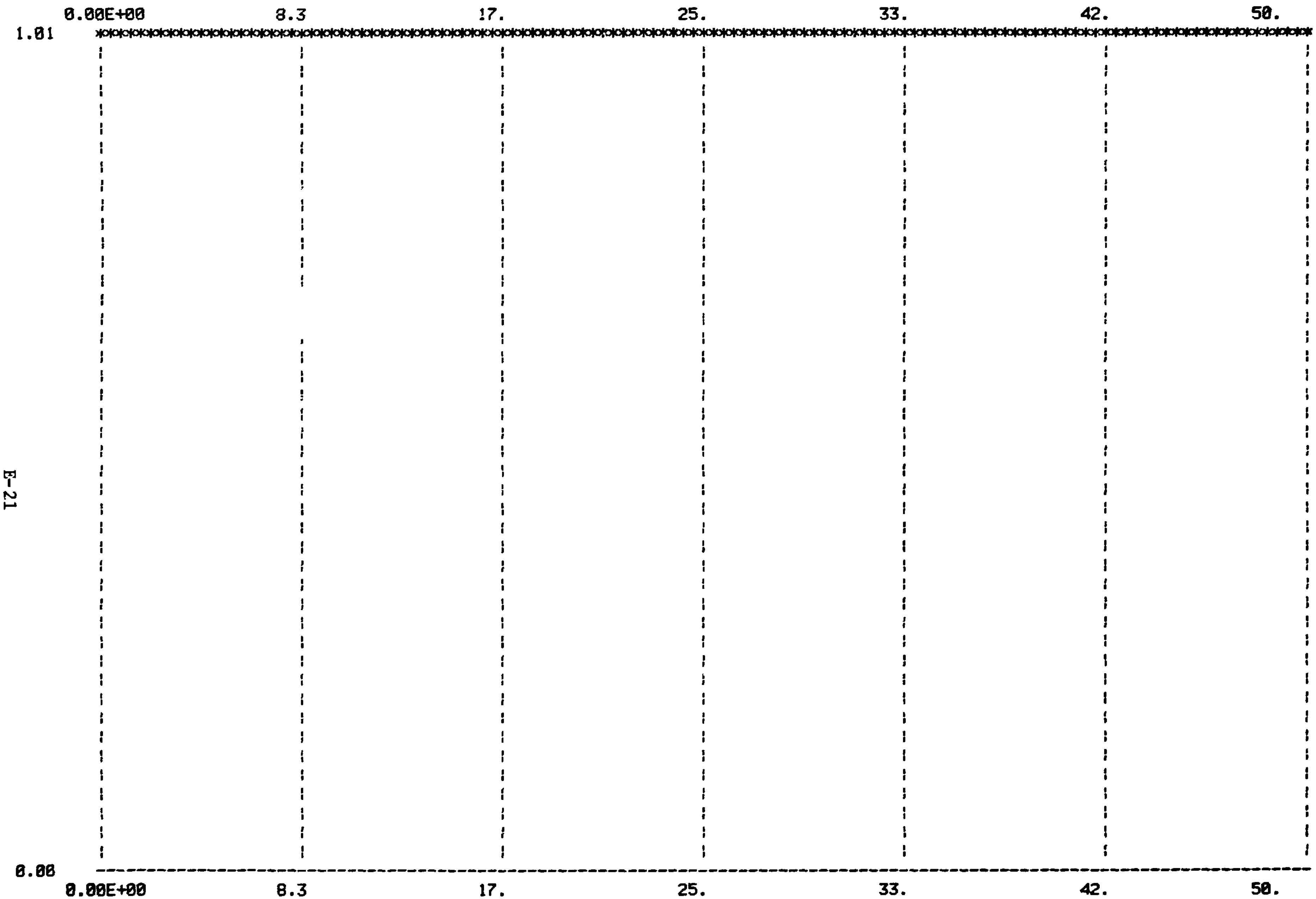
          21          22          23          24          25          26          27          28          29          30
T 0.83333E+01 0.87500E+01 0.91667E+01 0.95833E+01 0.10000E+02 0.10417E+02 0.10833E+02 0.11250E+02 0.11667E+02 0.12083E+02
P 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01 0.10000E+01
V 0.10008E+01 0.10009E+01 0.10009E+01 0.10010E+01 0.10010E+01 0.10010E+01 0.10011E+01 0.10011E+01 0.10012E+01 0.10012E+01
```

	31	32	33	34	35	36	37	38	39	40
T	0.12500E+02	0.12917E+02	0.13333E+02	0.13750E+02	0.14167E+02	0.14583E+02	0.15000E+02	0.15417E+02	0.15833E+02	0.16250E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10013E+01	0.10013E+01	0.10013E+01	0.10014E+01	0.10014E+01	0.10015E+01	0.10015E+01	0.10015E+01	0.10016E+01	0.10016E+01
	41	42	43	44	45	46	47	48	49	50
T	0.16667E+02	0.17083E+02	0.17500E+02	0.17917E+02	0.18333E+02	0.18750E+02	0.19167E+02	0.19583E+02	0.20000E+02	0.20417E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10017E+01	0.10017E+01	0.10018E+01	0.10018E+01	0.10018E+01	0.10019E+01	0.10019E+01	0.10020E+01	0.10020E+01	0.10020E+01
	51	52	53	54	55	56	57	58	59	60
T	0.20833E+02	0.21250E+02	0.21667E+02	0.22083E+02	0.22500E+02	0.22917E+02	0.23333E+02	0.23750E+02	0.24167E+02	0.24583E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10021E+01	0.10021E+01	0.10022E+01	0.10022E+01	0.10023E+01	0.10023E+01	0.10023E+01	0.10024E+01	0.10024E+01	0.10025E+01
	61	62	63	64	65	66	67	68	69	70
T	0.25000E+02	0.25417E+02	0.25833E+02	0.26250E+02	0.26667E+02	0.27083E+02	0.27500E+02	0.27917E+02	0.28333E+02	0.28750E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10025E+01	0.10025E+01	0.10026E+01	0.10026E+01	0.10027E+01	0.10027E+01	0.10028E+01	0.10028E+01	0.10028E+01	0.10029E+01
	71	72	73	74	75	76	77	78	79	80
T	0.29167E+02	0.29583E+02	0.30000E+02	0.30417E+02	0.30833E+02	0.31250E+02	0.31667E+02	0.32083E+02	0.32500E+02	0.32917E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10029E+01	0.10030E+01	0.10030E+01	0.10030E+01	0.10031E+01	0.10031E+01	0.10032E+01	0.10032E+01	0.10033E+01	0.10033E+01
	81	82	83	84	85	86	87	88	89	90
T	0.33333E+02	0.33750E+02	0.34167E+02	0.34583E+02	0.35000E+02	0.35417E+02	0.35833E+02	0.36250E+02	0.36667E+02	0.37083E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10033E+01	0.10034E+01	0.10034E+01	0.10035E+01	0.10035E+01	0.10035E+01	0.10036E+01	0.10036E+01	0.10037E+01	0.10037E+01
	91	92	93	94	95	96	97	98	99	100
T	0.37500E+02	0.37917E+02	0.38333E+02	0.38750E+02	0.39167E+02	0.39583E+02	0.40000E+02	0.40417E+02	0.40833E+02	0.41250E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10038E+01	0.10038E+01	0.10038E+01	0.10039E+01	0.10039E+01	0.10040E+01	0.10040E+01	0.10040E+01	0.10041E+01	0.10041E+01
	101	102	103	104	105	106	107	108	109	110
T	0.41667E+02	0.42083E+02	0.42500E+02	0.42917E+02	0.43333E+02	0.43750E+02	0.44167E+02	0.44583E+02	0.45000E+02	0.45417E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10042E+01	0.10042E+01	0.10043E+01	0.10043E+01	0.10043E+01	0.10044E+01	0.10044E+01	0.10045E+01	0.10045E+01	0.10045E+01
	111	112	113	114	115	116	117	118	119	120
T	0.45833E+02	0.46250E+02	0.46667E+02	0.47083E+02	0.47500E+02	0.47917E+02	0.48333E+02	0.48750E+02	0.49167E+02	0.49583E+02
P	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01
V	0.10046E+01	0.10046E+01	0.10047E+01	0.10047E+01	0.10048E+01	0.10048E+01	0.10048E+01	0.10049E+01	0.10049E+01	0.10050E+01
	121									
T	0.50000E+02									
P	0.10000E+01									
V	0.10050E+01									

INCIDENT PRESSURE PULSE:



INCIDENT PARTICLE VELOCITY:



+++ OPEN. 1 = FOR001 , Acc= DIRECT , Stat= SCRATCH

```
+++  OPEN,  12 = DIRTY:CYL.POS          , Acc= DIRECT , Stat= NEW
+++  OPEN,  14 = DIRTY:CYL.RST          , Acc= DIRECT , Stat= NEW

     4500 WORDS OF STORAGE REQUIRED FOR THIS RUN


   ICOMF    IDFL   ICOMJ     IN1    ICOMT
    223     223     363    3267    3267

   ICOMF    IDFL   ICOMJ     IN1    ICOMT
    223     223     363    3267    3267


             T             DT            DTC          KET         NOR         KSP         INX
 0.250000E-01  0.250000E-01  0.125000E-01            1           1           1           0


FM VECTOR     4
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00

    CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
     13.560  0.386458E+00               39                179670            90880

ELEMENT STIFFNESS MATRICES COMPUTED FOR UNIT     1 (SHELL)

    CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
     28.190  0.712826E+00               39                179670            90880
```

```
ASSEMBLY OF TOTAL STIFFNESS MATRIX COMPLETED.

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    28.460  0.717643E+00              39               179670           90880

DETERMINANT OF STIFFNESS MATRIX=   0.1167315E+07*10.**    60.   NUMBER OF NEGATIVE ROOTS =   0
     216 EQUATIONS.  AVERAGE BAND WIDTH =          15
 MATRIX DECOMPOSITION COMPLETED.

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    29.150  0.734831E+00              39               179670           90880

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    30.280  0.756836E+00              39               179670           90880

 ICOMF    IDFL   ICOMJ     IN1    ICOMT
  223     223     363     3267    3267

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    32.450  0.825130E+00              43               297100           90830

 ICOMF    IDFL   ICOMJ     IN1    ICOMT
  223     223     363     3267    3267

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    35.300  0.930143E+00              47               414530           90880

 ICOMF    IDFL   ICOMJ     IN1    ICOMT
  223     223     363     3267    3267

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    37.850  0.100547E+01              51               531960           90880

 ICOMF    IDFL   ICOMJ     IN1    ICOMT
  223     223     363     3267    3267

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
    40.070  0.109928E+01              55               649390           90880

 ICOMF    IDFL   ICOMJ     IN1    ICOMT
  223     223     363     3267    3267

   CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
```

```
 42.290  0.116849E+01              59              766820          90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  44.550  0.124082E+01              63               884250           90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  46.840  0.131712E+01              67              1001680           90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  49.130  0.148066E+01              71              1119110           90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  51.400  0.193301E+01              75              1236540           90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  53.720  0.209883E+01              79              1353970           90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  56.040  0.236263E+01              83              1471400           90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
223     223    363    3267   3267

 CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  58.570  0.262363E+01              87              1588830           90880
```

```
ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   60.890  0.285547E+01              91              1706260           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   63.170  0.296563E+01              95              1823690           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   65.410  0.304701E+01              99              1941120           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   67.730  0.312617E+01             103              2058550           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   70.090  0.321081E+01             107              2175980           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   72.400  0.351595E+01             111              2293410           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
 223     223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   74.740  0.370951E+01             115              2410840           90880

ICOMF   IDFL   ICOMJ    IN1   ICOMT
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223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   77.110  0.389596E+01             119              2528270           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   79.400  0.409948E+01             123              2645700           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   81.730  0.420228E+01             127              2763130           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   84.070  0.430599E+01             131              2880560           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   86.430  0.441582E+01             135              2997990           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   88.670  0.452031E+01             139              3115420           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
   91.060  0.463464E+01             143              3232850           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267
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 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  93.530  0.473965E+01              147               3350280            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223    363     3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  95.950  0.482682E+01              151               3467710            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223    363     3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  98.150  0.493249E+01              155               3585140            90880

RESTART DATA FOR T =    0.750000 WRITTEN AT LOCATION      0 ON PERMANENT FILE DIRTY*CYL.RST

POST PROCESSING RESPONSE FILE LOCATION IS    465

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223    363     3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 100.860  0.505150E+01              159               3702570            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223    363     3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 103.100  0.515462E+01              163               3820000            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223    363     3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 105.580  0.528581E+01              167               3937430            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223    363     3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 107.870  0.541764E+01              171               4054860            90880
```

```
 ICOMF   IDFL  ICOMJ    IN1    ICOMT
  223     223    363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  110.160  0.551882E+01              175               4172290            90830

 ICOMF   IDFL  ICOMJ    IN1    ICOMT
  223     223    363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  112.410  0.559531E+01              179               4289720            90880

 ICOMF   IDFL  ICOMJ    IN1    ICOMT
  223     223    363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  114.660  0.570866E+01              183               4407150            90880

 ICOMF   IDFL  ICOMJ    IN1    ICOMT
  223     223    363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  116.880  0.578698E+01              187               4524580            90880

 ICOMF   IDFL  ICOMJ    IN1    ICOMT
  223     223    363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  119.260  0.586328E+01              191               4642010            90880

 ICOMF   IDFL  ICOMJ    IN1    ICOMT
  223     223    363    3267    3267

TIME INCREMENT HAS BEEN CHANGED TO    0.500000E-01

              T            DT            DTC          KET        NOR        KSP        INX
 0.105000E+01  0.500000E-01  0.250000E-01              1          1          1          0
 0.4000E+02 -0.4000E+02  0.0000E+00 -0.1000E+01

FM VECTOR      4
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
```

0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02
0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02
0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06
0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02
0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02
0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06
0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02
0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02
0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06
0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02
0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02
0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06
0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5329E-06	0.1197E-02
0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02
0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06
0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02
0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02
0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06
0.1197E-02	0.1197E-02	0.5829E-06	0.1197E-02	0.1197E-02	0.5829E-06	0.0000E+00	0.0000E+00	-0.7399E-02	0.0000E+00

CP TIME	ELAPSED TIME	I/O REQUESTS	WORDS TRANSFERRED	WORDS STORED
121.790	0.596562E+01	195	4759440	90880

ICOMF	IDFL	ICOMJ	IN1	ICOMT
223	223	363	3267	3267

ELEMENT STIFFNESS MATRICES COMPUTED FOR UNIT 1 (SHELL)

CP TIME	ELAPSED TIME	I/O REQUESTS	WORDS TRANSFERRED	WORDS STORED
140.120	0.637096E+01	203	4896886	90880

ASSEMBLY OF TOTAL STIFFNESS MATRIX COMPLETED.

CP TIME	ELAPSED TIME	I/O REQUESTS	WORDS TRANSFERRED	WORDS STORED
140.370	0.637832E+01	203	4896886	90880

DETERMINANT OF STIFFNESS MATRIX= 0.2157060E-04*10.** -10. NUMBER OF NEGATIVE ROOTS = 0
216 EQUATIONS. AVERAGE BAND WIDTH = 15
MATRIX DECOMPOSITION COMPLETED.

CP TIME	ELAPSED TIME	I/O REQUESTS	WORDS TRANSFERRED	WORDS STORED
141.070	0.639063E+01	203	4896886	90880

CP TIME	ELAPSED TIME	I/O REQUESTS	WORDS TRANSFERRED	WORDS STORED
141.470	0.639766E+01	203	4896886	90880

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ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  143.710  0.647767E+01             207              5014316           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  145.970  0.658633E+01             211              5131746           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  148.320  0.670195E+01             215              5249176           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  150.830  0.682845E+01             219              5366606           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  153.220  0.694850E+01             223              5484036           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  155.490  0.702917E+01             227              5601466           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  157.770  0.710898E+01             231              5718896           90880

ICOMF   IDFL  ICOMJ   IN1   ICOMT
 223    223    363   3267   3267
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  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 160.130  0.718900E+01             235              5836326           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 162.420  0.731497E+01             239              5953756           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 164.930  0.745182E+01             243              6071186           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 167.210  0.756550E+01             247              6188616           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 169.540  0.763932E+01             251              6306046           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 171.790  0.771048E+01             255              6423476           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 174.130  0.778750E+01             259              6540906           90880

ICOMF    IDFL   ICOMJ    IN1    ICOMT
 223     223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
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  176.440  0.786178E+01          263           6658336          90880

 ICOMF    IDFL   ICOMJ    IN1    ICOMT
  223      223    363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  178.700  0.793763E+01             267              6775766           90880

 ICOMF    IDFL   ICOMJ    IN1    ICOMT
  223      223    363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  180.950  0.802832E+01             271              6893156           90880

 ICOMF    IDFL   ICOMJ    IN1    ICOMT
  223      223    363    3267    3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  183.300  0.811615E+01             275              7010626           90880

 ICOMF    IDFL   ICOMJ    IN1    ICOMT
  223      223    363    3267    3267

TIME INCREMENT HAS BEEN CHANGED TO    0.100000E+00

              T              DT             DTC          KET         NOR         KSP         INX
 0.210000E+01  0.100000E+00  0.500000E-01                  1           1           1           0
 0.2000E+02 -0.2000E+02  0.0000E+00 -0.1000E+01

FM VECTOR     4
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1157E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
 0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02
 0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02
 0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06  0.1197E-02  0.1197E-02  0.5829E-06
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0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02
0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02
0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06
0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02
0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02
0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06
0.1197E-02 0.1197E-02 0.5829E-06 0.1197E-02 0.1197E-02 0.5829E-06 0.0000E+00 0.0000E+00 -0.1233E-01 0.0000E+00

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  185.870  0.820579E+01             279              7128056           90880

  RESTART DATA FOR T =   2.000000 WRITTEN AT LOCATION    54 ON PERMANENT FILE DIRTY*CYL.RST

  POST PROCESSING RESPONSE FILE LOCATION IS   915

  ICOMF   IDFL  ICOMJ    IN1   ICOMT
   223    223    363    3267   3267
ELEMENT STIFFNESS MATRICES COMPUTED FOR UNIT    1 (SHELL)

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  203.210  0.857448E+01             287              7265502           90880

 ASSEMBLY OF TOTAL STIFFNESS MATRIX COMPLETED.

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  203.490  0.858047E+01             287              7265502           90880

DETERMINANT OF STIFFNESS MATRIX=   0.2017339E+00*10.**   -80.   NUMBER OF NEGATIVE ROOTS =   0
    216 EQUATIONS.  AVERAGE BAND WIDTH =          15
 MATRIX DECOMPOSITION COMPLETED.

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  204.220  0.859681E+01             287              7265502           90880

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  204.650  0.860762E+01             287              7265502           90880

 ICOMF   IDFL  ICOMJ    IN1   ICOMT
  223    223    363    3267   3267

  CP TIME  ELAPSED TIME    I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
  206.970  0.869798E+01             291              7382932           90880
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ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  209.350  0.877663E+01              295               7500362            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  211.630  0.885716E+01              299               7617792            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  213.930  0.892845E+01              303               7735222            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  216.240  0.899980E+01              307               7852652            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  218.420  0.907266E+01              311               7970082            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  220.780  0.915417E+01              315               8087512            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267    3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  223.080  0.924147E+01              319               8204942            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
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223     223     363   3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 225.330  0.931894E+01              323              8322372           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 227.410  0.941667E+01              327              8439802           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 229.710  0.950195E+01              331              8557232           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 232.120  0.958678E+01              335              8674662           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 234.470  0.966113E+01              339              8792092           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 236.790  0.978346E+01              343              8909522           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267

 CP TIME  ELAPSED TIME     I/O REQUESTS    WORDS TRANSFERRED    WORDS STORED
 239.180  0.987767E+01              347              9026952           90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223     223     363    3267    3267
```

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 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 241.700  0.996445E+01              351               9144382            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 244.050  0.100493E+02              355               9261812            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 246.440  0.101296E+02              359               9379242            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 246.[illegible]40  0.102105E+02              363               9496672            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 251.310  0.102848E+02              367               9614102            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 253.540  0.103596E+02              371               9731532            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 255.920  0.104507E+02              375               9848962            90880

ICOMF    IDFL   ICOMJ     IN1    ICOMT
 223      223     363    3267     3267

 CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
 258.400  0.105355E+02              379               9966392            90880
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ICOMF   IDFL  ICOMJ    IN1   ICOMT
 223     223    363   3267   3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  260.800  0.106170E+02              383              10083822            90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
 223     223    363   3267   3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  263.200  0.106955E+02              387              10201252            90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
 223     223    363   3267   3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  265.490  0.107757E+02              391              10318682            90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
 223     223    363   3267   3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  267.960  0.108583E+02              395              10436112            90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
 223     223    363   3267   3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  270.320  0.109418E+02              399              10553542            90880

ICOMF   IDFL  ICOMJ    IN1   ICOMT
 223     223    363   3267   3267

  CP TIME  ELAPSED TIME     I/O REQUESTS     WORDS TRANSFERRED     WORDS STORED
  272.760  0.110248E+02              403              10670972            90880

 RESTART DATA FOR T =    5.000000 WRITTEN AT LOCATION    108 ON PERMANENT FILE DIRTY*CYL.RST

 POST PROCESSING RESPONSE FILE LOCATION IS  1365

 SECTOR ADDRESS OF RESPONSE FILE DIRTY*CYL.POS        AT EXIT IS  1365
```

```
SECTOR ADDRESS OF RESTART FILE DIRTY*CYL.RST        AT EXIT IS   162

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+          A U X I L I A R Y   S T O R A G E   T A B L E              +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                                      +
+LDI Ext-filnam Unit EC Opt PRU  Cdloc   Next  Limit     Read Written +
+  1 FOR001        1  1 T    64     33     33  20000   247068  120477 +
+ 10 DIRTY:CYL.PO 12  1 UP   64   1365   1365  20000        0   82173 +
+    S                                                                 +
+ 12 DIRTY:CYL.RS 14  1 UP   64    162    162  20000        0    9939 +
+    T                                                                 +
+ 14 DIRTY:CYL.PR 16  1 AX   64     28  20000  20000   152178       0 +
+    E                                                                 +
+                                                                      +
+                     4 Active devices ( 0 full)                       +
+      0 Tp ops,  1194 Writes,   565 Reads      611835 Words XFD       +
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

+++  CLOSE, 12
+++  CLOSE, 14
+++  OPEN,  12 = DIRTY:CYL.POS          , Acc= DIRECT , Stat= OLD
+++  CLOSE, 12
```

TRANSIENT RESPONSE HISTORIES:

	1	2	3	4	5	6	7	8	9	10
T	0.00000E+00	0.25000E-01	0.50000E-01	0.75000E-01	0.10000E+00	0.12500E+00	0.15000E+00	0.17500E+00	0.20000E+00	0.22500E+00
10/3 D	0.00000E+00	-0.12200E-05	-0.74684E-05	-0.23222E-04	-0.50250E-04	-0.86229E-04	-0.12524E-03	-0.15897E-03	-0.17775E-03	-0.17111E-03
10/2 D	0.00000E+00	0.27946E-08	0.28548E-07	0.14705E-06	0.51685E-06	0.14126E-05	0.32386E-05	0.65662E-05	0.12312E-04	0.22358E-04
1/3 V	0.00000E+00	-0.27830E+00	-0.72955E+00	-0.10586E+01	-0.12946E+01	-0.14646E+01	-0.15883E+01	-0.16793E+01	-0.17468E+01	-0.17971E+01
10/3 V	0.00000E+00	-0.97600E-04	-0.40227E-03	-0.85804E-03	-0.13042E-02	-0.15740E-02	-0.15469E-02	-0.11517E-02	-0.35029E-03	0.88132E-03
10/2 V	0.00000E+00	0.22357E-06	0.18367E-05	0.76435E-05	0.21940E-04	0.49719E-04	0.96365E-04	0.16984E-03	0.28983E-03	0.51388E-03
19/3 V	0.00000E+00	-0.48206E-04	-0.19742E-03	-0.41794E-03	-0.63015E-03	-0.75254E-03	-0.72692E-03	-0.52096E-03	-0.11950E-03	0.48358E-03
1/0 P	0.11765E+00	0.16339E+01	0.12203E+01	0.89905E+00	0.67930E+00	0.53466E+00	0.44023E+00	0.37910E+00	0.34005E+00	0.31600E+00
10/0 P	0.00000E+00	0.61501E-03	0.13112E-02	0.15903E-02	0.12989E-02	0.55402E-03	-0.47723E-03	-0.15613E-02	-0.29301E-02	-0.42472E-02
19/0 P	0.00000E+00	0.30375E-03	0.63956E-03	0.76422E-03	0.60985E-03	0.23282E-03	-0.28114E-03	-0.86254E-03	-0.14824E-02	-0.21231E-02

	11	12	13	14	15	16	17	18	19	20
T	0.25000E+00	0.27500E+00	0.30000E+00	0.32500E+00	0.35000E+00	0.37500E+00	0.40000E+00	0.42500E+00	0.45000E+00	0.47500E+00
10/3 D	-0.12824E-03	-0.38131E-04	0.11095E-03	0.33286E-03	0.64611E-03	0.10774E-02	0.16658E-02	0.24671E-02	0.35567E-02	0.50289E-02
10/2 D	0.41273E-04	0.80347E-04	0.16579E-03	0.35305E-03	0.74836E-03	0.15353E-02	0.29997E-02	0.55406E-02	0.96532E-02	0.15873E-01
1/3 V	-0.18348E+01	-0.18633E+01	-0.18852E+01	-0.19020E+01	-0.19150E+01	-0.19250E+01	-0.19328E+01	-0.19391E+01	-0.19442E+01	-0.19484E+01
10/3 V	0.25484E-02	0.46603E-02	0.72661E-02	0.10487E-01	0.14574E-01	0.19931E-01	0.27141E-01	0.36961E-01	0.50207E-01	0.67569E-01
10/2 V	0.99926E-03	0.21267E-02	0.47085E-02	0.10273E-01	0.21351E-01	0.41603E-01	0.75548E-01	0.12773E+00	0.20128E+00	0.23632E+00
19/3 V	0.12814E-02	0.22581E-02	0.33950E-02	0.46717E-02	0.60701E-02	0.75660E-02	0.91321E-02	0.10746E-01	0.12389E-01	0.14043E-01
1/0 P	0.30265E+00	0.29674E+00	0.29607E+00	0.29894E+00	0.30425E+00	0.31144E+00	0.31984E+00	0.32892E+00	0.33826E+00	0.34771E+00
10/0 P	-0.54631E-02	-0.65645E-02	-0.74057E-02	-0.78132E-02	-0.75270E-02	-0.59570E-02	-0.26023E-02	0.31738E-02	0.12037E-01	0.24399E-01
19/0 P	-0.27315E-02	-0.33140E-02	-0.38574E-02	-0.43731E-02	-0.48708E-02	-0.53121E-02	-0.57207E-02	-0.61111E-02	-0.64931E-02	-0.68676E-02

	21	22	23	24	25	26	27	28	29	30
T	0.50000E+00	0.52500E+00	0.55000E+00	0.57500E+00	0.60000E+00	0.62500E+00	0.65000E+00	0.67500E+00	0.70000E+00	0.72500E+00
10/3 D	0.69913E-02	0.95550E-02	0.12822E-01	0.16871E-01	0.21752E-01	0.27485E-01	0.34063E-01	0.41470E-01	0.49688E-01	0.58710E-01
10/2 D	0.24687E-01	0.36427E-01	0.51189E-01	0.68813E-01	0.88939E-01	0.11113E+00	0.13500E+00	0.16033E+00	0.18709E+00	0.21537E+00
1/3 V	-0.19519E+01	-0.19545E+01	-0.19565E+01	-0.19581E+01	-0.19594E+01	-0.19606E+01	-0.19619E+01	-0.19630E+01	-0.19640E+01	-0.19648E+01
10/3 V	0.89425E-01	0.11567E+00	0.14565E+00	0.17827E+00	0.21224E+00	0.24637E+00	0.27990E+00	0.31264E+00	0.34482E+00	0.37695E+00
10/2 V	0.40877E+00	0.53040E+00	0.65059E+00	0.75938E+00	0.85070E+00	0.92430E+00	0.98528E+00	0.10415E+01	0.10996E+01	0.11625E+01
19/3 V	0.15689E-01	0.17310E-01	0.18886E-01	0.20399E-01	0.21833E-01	0.23179E-01	0.24449E-01	0.25686E-01	0.26982E-01	0.28509E-01
1/0 P	0.35727E+00	0.36690E+00	0.37657E+00	0.38611E+00	0.39535E+00	0.40422E+00	0.41267E+00	0.42089E+00	0.42893E+00	0.43675E+00
10/0 P	0.40271E-01	0.59138E-01	0.80147E-01	0.10204E+00	0.12358E+00	0.14387E+00	0.16195E+00	0.17792E+00	0.19187E+00	0.20422E+00
19/0 P	-0.72324E-02	-0.75914E-02	-0.79259E-02	-0.82302E-02	-0.84876E-02	-0.86540E-02	-0.87115E-02	-0.85390E-02	-0.80027E-02	-0.68653E-02

	31	32	33	34	35	36	37	38	39	40
T	0.75000E+00	0.77500E+00	0.80000E+00	0.82500E+00	0.85000E+00	0.87500E+00	0.90000E+00	0.92500E+00	0.95000E+00	0.97500E+00
10/3 D	0.68541E-01	0.79196E-01	0.90699E-01	0.10308E+00	0.11640E+00	0.13069E+00	0.14603E+00	0.16241E+00	0.17943E+00	0.19640E+00
10/2 D	0.24525E+00	0.27677E+00	0.30983E+00	0.34430E+00	0.38008E+00	0.41711E+00	0.45544E+00	0.49514E+00	0.53622E+00	0.57863E+00
1/3 V	-0.19656E+01	-0.19668E+01	-0.19686E+01	-0.19711E+01	-0.19741E+01	-0.19776E+01	-0.19813E+01	-0.19853E+01	-0.19898E+01	-0.19949E+01
10/3 V	0.40951E+00	0.44287E+00	0.47738E+00	0.51347E+00	0.55151E+00	0.59196E+00	0.63547E+00	0.67459E+00	0.68711E+00	0.67058E+00
10/2 V	0.12283E+01	0.12927E+01	0.13521E+01	0.14058E+01	0.14562E+01	0.15067E+01	0.15599E+01	0.16155E+01	0.16708E+01	0.17223E+01
19/3 V	0.30558E-01	0.33565E-01	0.38150E-01	0.45111E-01	0.55399E-01	0.70028E-01	0.89940E-01	0.11581E+00	0.14783E+00	0.18557E+00
1/0 P	0.44414E+00	0.45086E+00	0.45677E+00	0.46190E+00	0.46644E+00	0.47059E+00	0.47447E+00	0.47801E+00	0.48104E+00	0.48342E+00
10/0 P	0.21524E+00	0.22466E+00	0.23182E+00	0.23594E+00	0.23805E+00	0.23734E+00	0.23414E+00	0.27925E+00	0.41465E+00	0.47416E+00
19/0 P	-0.47841E-02	-0.12696E-02	0.43246E-02	0.12773E-01	0.24945E-01	0.41650E-01	0.63523E-01	0.90840E-01	0.12335E+00	0.16017E+00

41 42 43 44 45 46 47 48 49 50

T	0.10000E+01	0.10500E+01	0.11000E+01	0.11500E+01	0.12000E+01	0.12500E+01	0.13000E+01	0.13500E+01	0.14000E+01	0.14500E+01
10/3 D	0.21246E+00	0.23923E+00	0.25785E+00	0.26807E+00	0.27113E+00	0.26905E+00	0.26328E+00	0.25499E+00	0.24517E+00	0.23464E+00
10/2 D	0.62226E+00	0.71268E+00	0.80700E+00	0.90491E+00	0.10056E+01	0.11075E+01	0.12086E+01	0.13071E+01	0.14011E+01	0.14834E+01
1/3 V	-0.20006E+01	-0.20130E+01	-0.20254E+01	-0.20366E+01	-0.20478E+01	-0.20591E+01	-0.20693E+01	-0.20775E+01	-0.20844E+01	-0.20914E+01
10/3 V	0.61410E+00	0.45669E+00	0.28816E+00	0.12049E+00	0.18327E-02	-0.84766E-01	-0.14612E+00	-0.18562E+00	-0.20684E+00	-0.21445E+00
10/2 V	0.17681E+01	0.18487E+01	0.19242E+01	0.19923E+01	0.20351E+01	0.20395E+01	0.20055E+01	0.19337E+01	0.18271E+01	0.17060E+01
19/3 V	0.22787E+00	0.32514E+00	0.41575E+00	0.48412E+00	0.54121E+00	0.59306E+00	0.64463E+00	0.69533E+00	0.74231E+00	0.78542E+00
1/0 P	0.48514E+00	0.48770E+00	0.49086E+00	0.49474E+00	0.49842E+00	0.50157E+00	0.50509E+00	0.50977E+00	0.51511E+00	0.51992E+00
10/0 P	0.67733E+00	0.63492E+00	0.73815E+00	0.65764E+00	0.61760E+00	0.59809E+00	0.59183E+00	0.59729E+00	0.61310E+00	0.63636E+00
19/0 P	0.19980E+00	0.27869E+00	0.34637E+00	0.39752E+00	0.43491E+00	0.46611E+00	0.49614E+00	0.52419E+00	0.54739E+00	0.56553E+00

	51	52	53	54	55	56	57	58	59	60
T	0.15000E+01	0.15500E+01	0.16000E+01	0.16500E+01	0.17000E+01	0.17500E+01	0.18000E+01	0.18500E+01	0.19000E+01	0.19500E+01
10/3 D	0.22393E+00	0.21327E+00	0.20259E+00	0.19164E+00	0.18021E+00	0.16827E+00	0.15595E+00	0.14345E+00	0.13089E+00	0.11831E+00
10/2 D	0.15722E+01	0.16512E+01	0.17288E+01	0.18065E+01	0.18849E+01	0.19628E+01	0.20390E+01	0.21129E+01	0.21857E+01	0.22587E+01
1/3 V	-0.20995E+01	-0.21080E+01	-0.21159E+01	-0.21215E+01	-0.21225E+01	-0.21155E+01	-0.20970E+01	-0.20652E+01	-0.20225E+01	-0.19752E+01
10/3 V	-0.21413E+00	-0.21237E+00	-0.21479E+00	-0.22303E+00	-0.23416E+00	-0.24361E+00	-0.24897E+00	-0.25100E+00	-0.25162E+00	-0.25159E+00
10/2 V	0.16062E+01	0.15538E+01	0.15474E+01	0.15633E+01	0.15707E+01	0.15477E+01	0.14993E+01	0.14582E+01	0.14520E+01	0.14697E+01
19/3 V	0.82766E+00	0.87098E+00	0.91413E+00	0.95553E+00	0.99617E+00	0.10386E+01	0.10842E+01	0.11328E+01	0.11855E+01	0.12475E+01
1/0 P	0.52368E+00	0.52741E+00	0.53266E+00	0.54122E+00	0.55547E+00	0.57819E+00	0.61181E+00	0.65652E+00	0.70865E+00	0.76096E+00
10/0 P	0.66173E+00	0.68437E+00	0.69997E+00	0.70775E+00	0.71154E+00	0.71599E+00	0.72310E+00	0.73162E+00	0.73921E+00	0.74481E+00
19/0 P	0.58095E+00	0.59585E+00	0.60895E+00	0.61803E+00	0.62406E+00	0.62842E+00	0.63143E+00	0.63069E+00	0.62469E+00	0.60854E+00

	61	62	63	64	65	66	67	68	69	70
T	0.20000E+01	0.21000E+01	0.22000E+01	0.23000E+01	0.24000E+01	0.25000E+01	0.26000E+01	0.27000E+01	0.28000E+01	0.29000E+01
10/3 D	0.10577E+00	0.81803E-01	0.60596E-01	0.43010E-01	0.29100E-01	0.18356E-01	0.93135E-02	0.48520E-03	-0.80781E-02	-0.15453E-01
10/2 D	0.23324E+01	0.24801E+01	0.26325E+01	0.27985E+01	0.29804E+01	0.31721E+01	0.33658E+01	0.35546E+01	0.37383E+01	0.39237E+01
1/3 V	-0.19310E+01	-0.18648E+01	-0.18414E+01	-0.18273E+01	-0.18039E+01	-0.18077E+01	-0.18306E+01	-0.18344E+01	-0.18222E+01	-0.18206E+01
10/3 V	-0.24972E+00	-0.22971E+00	-0.19444E+00	-0.15727E+00	-0.12094E+00	-0.93940E-01	-0.86908E-01	-0.89557E-01	-0.81608E-01	-0.65886E-01
10/2 V	0.14773E+01	0.14767E+01	0.15705E+01	0.17511E+01	0.18867E+01	0.19461E+01	0.19284E+01	0.18478E+01	0.18251E+01	0.18829E+01
19/3 V	0.13092E+01	0.13857E+01	0.14146E+01	0.14242E+01	0.14282E+01	0.14370E+01	0.14617E+01	0.15033E+01	0.15585E+01	0.16143E+01
1/0 P	0.80474E+00	0.85211E+00	0.86783E+00	0.87730E+00	0.88971E+00	0.89062E+00	0.87826E+00	0.87268E+00	0.87976E+00	0.88503E+00
10/0 P	0.74787E+00	0.75995E+00	0.78324E+00	0.81402E+00	0.84698E+00	0.87296E+00	0.88300E+00	0.88216E+00	0.88521E+00	0.89536E+00
19/0 P	0.63766E+00	0.71377E+00	0.74853E+00	0.76429E+00	0.77327E+00	0.78563E+00	0.81098E+00	0.85252E+00	0.90670E+00	0.95946E+00

	71	72	73	74	75	76	77	78	79	80
T	0.30000E+01	0.31000E+01	0.32000E+01	0.33000E+01	0.34000E+01	0.35000E+01	0.36000E+01	0.37000E+01	0.38000E+01	0.39000E+01
10/3 D	-0.21583E-01	-0.26946E-01	-0.31417E-01	-0.34489E-01	-0.36088E-01	-0.37083E-01	-0.38725E-01	-0.41200E-01	-0.43730E-01	-0.45945E-01
10/2 D	0.41112E+01	0.42918E+01	0.44609E+01	0.46221E+01	0.47789E+01	0.49338E+01	0.50911E+01	0.52547E+01	0.54231E+01	0.55910E+01
1/3 V	-0.18230E+01	-0.18147E+01	-0.18142E+01	-0.18282E+01	-0.18309E+01	-0.18129E+01	-0.17834E+01	-0.17413E+01	-0.16981E+01	-0.16857E+01
10/3 V	-0.56714E-01	-0.50549E-01	-0.38866E-01	-0.22572E-01	-0.94119E-02	-0.10496E-01	-0.22347E-01	-0.27149E-01	-0.23453E-01	-0.20843E-01
10/2 V	0.18682E+01	0.17446E+01	0.16366E+01	0.15864E+01	0.15515E+01	0.15461E+01	0.15995E+01	0.16725E+01	0.16947E+01	0.16642E+01
19/3 V	0.16447E+01	0.16423E+01	0.16284E+01	0.16260E+01	0.16391E+01	0.16501E+01	0.16433E+01	0.16301E+01	0.16312E+01	0.16443E+01
1/0 P	0.88551E+00	0.88844E+00	0.88966E+00	0.88641E+00	0.89068E+00	0.91067E+00	0.94286E+00	0.98239E+00	0.10171E+01	0.10268E+01
10/0 P	0.90497E+00	0.91228E+00	0.92237E+00	0.93802E+00	0.95359E+00	0.95825E+00	0.95158E+00	0.94559E+00	0.94651E+00	0.95158E+00
19/0 P	0.98903E+00	0.98637E+00	0.96595E+00	0.95147E+00	0.95347E+00	0.96032E+00	0.95564E+00	0.94186E+00	0.93482E+00	0.93967E+00

	81	82	83	84	85	86	87	88	89	90
T	0.40000E+01	0.41000E+01	0.42000E+01	0.43000E+01	0.44000E+01	0.45000E+01	0.46000E+01	0.47000E+01	0.48000E+01	0.49000E+01
10/3 D	-0.47842E-01	-0.49326E-01	-0.50615E-01	-0.51914E-01	-0.52936E-01	-0.53782E-01	-0.55296E-01	-0.57776E-01	-0.60327E-01	-0.62096E-01
10/2 D	0.57561E+01	0.59311E+01	0.61134E+01	0.62996E+01	0.64833E+01	0.66630E+01	0.68384E+01	0.70110E+01	0.71833E+01	0.73543E+01

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 1/3 V-0.17076E+01-0.17360E+01-0.17580E+01-0.17641E+01-0.17474E+01-0.17263E+01-0.17285E+01-0.17465E+01-0.17576E+01-0.17611E+01
10/3 V-0.17097E-01-0.12589E-01-0.13194E-01-0.12773E-01-0.76704E-02-0.92522E-02-0.21027E-01-0.28581E-01-0.22423E-01-0.12957E-01
10/2 V 0.16780E+01 0.17808E+01 0.18662E+01 0.18575E+01 0.18169E+01 0.17769E+01 0.17315E+01 0.17203E+01 0.17257E+01 0.16947E+01
19/3 V 0.16511E+01 0.16479E+01 0.16553E+01 0.16776E+01 0.16942E+01 0.17029E+01 0.17235E+01 0.17491E+01 0.17569E+01 0.17479E+01
 1/0 P 0.10076E+01 0.97800E+00 0.95670E+00 0.95354E+00 0.96907E+00 0.98644E+00 0.98473E+00 0.96610E+00 0.94993E+00 0.94682E+00
10/0 P 0.95988E+00 0.96669E+00 0.97138E+00 0.97555E+00 0.98066E+00 0.98068E+00 0.97252E+00 0.96502E+00 0.96802E+00 0.97787E+00
19/0 P 0.94507E+00 0.94383E+00 0.94608E+00 0.95932E+00 0.97372E+00 0.98396E+00 0.99812E+00 0.10149E+01 0.10212E+01 0.10117E+01

         91
     T 0.50000E+01
10/3 D-0.63325E-01
10/2 D 0.75225E+01
 1/3 V-0.17631E+01
10/3 V-0.11638E-01
10/2 V 0.16685E+01
19/3 V 0.17350E+01
 1/0 P 0.95402E+00
10/0 P 0.98446E+00
19/0 P 0.99407E+00
```

APPENDIX F

USER INFORMATION FOR THE POSTPROCESSOR POSTPR

This appendix includes a copy of the users manual, and a sample input deck and subsequent output for the infinte cylindrical shell problem presented in Section 4.

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                    P O S T P R

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      THIS FUNCTIONAL COMPONENT OF THE UNDERWATER SHOCK ANALYSIS CODE
      IS RESPONSIBLE FOR THE TABULATION AND PRINTER-PLOT GRAPHIC DISPLAY
      OF SELECTED TRANSIENT RESPONSES AND PSEUDO-VELOCITY SHOCK SPECTRA
      UPON COMPLETION OF AN UNDERWATER SHOCK ANALYSIS OF A SUBMERGED
      STRUCTURE. IT CAN ALSO CREATE A PERMANENT FILE CONTAINING A SERIES
      OF SNAPSHOTS OF THE DEFORMED STRUCTURE AT USER SPECIFIED TIMES

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      THIS PROGRAM WAS DEVELOPED AND CODED BY JOHN A. DERUNTZ, JR.
      OF LOCKHEED MISSILES AND SPACE CO. RESEARCH LABS IN PALO ALTO
      CALIFORNIA. PLEASE CONSULT WITH AUTHOR BEFORE MAKING CHANGES
      AND ALSO REPORT ANY MALFUNCTIONS OR PROBLEMS. WRITE IN CARE OF
      LOCKHEED PALO ALTO RESEARCH LABORATORY, BLDG 205, DEPT 52-33,
      3251 HANOVER ST., PALO ALTO, CALIF., 94304 OR CALL 415-493-4411
      EXTS. 45069 OR 45133.                            SEPTEMBER, 1980

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 W A R N I N G    F R O M    T H E    P R O G R A M M E R    G E N E R A L

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      THIS CODE CONTAINS THE SPECIAL INGREDIENT DMGASP NOT FOUND IN
      OTHER BRANDS. DMGASP IS A DATA MANAGEMENT UTILITY MODULE THAT
      WILL ACTIVATE AND DEACTIVATE ALL AUXILIARY STORAGE DATA FILES
      REFERENCED BY THE CODE. HENCE THE NAMES OF SUCH FILES SHOULD NOT
      APPEAR ON ANY CONTROL CARDS IN THE RUN STREAM WHICH MIGHT NORMALLY
      ACTIVATE AND DEACTIVATE THE FILES. THE USER IS ALSO CAUTIONED THAT
      PREVIOUSLY CREATED FILES MUST ALREADY BE RESIDENT IN THE SYSTEM
      BEFORE THE RUN IS INITIATED. IF A FILE HAS BEEN ROLLED-OUT TO TAPE
      DMGASP WILL ATTEMPT TO HAVE THE FILE ROLLED-IN EVERY 15 SECONDS
      FOR UP TO 6 MINUTES ON THE UNIVAC 1100-EXEC 8 OPERATING SYSTEM.
      IF AN EXISTING DATA FILE HAS NOT BEEN REFERENCED FOR SOME TIME IT
      IS THEREFORE GOOD POLICY TO SIMPLY ACTIVATE AND DEACTIVATE THE
      FILE BEFORE EXECUTION OF THIS CODE. IF THE USER ATTEMPTS TO CREATE
      A NEW DATA FILE WITH A NAME WHICH IS ALREADY ASSIGNED TO AN
      EXISTING FILE, THE UNIVAC VERSION OF DMGASP WILL MODIFY THE NAME
      OF THE FILE GENERATED BY THIS RUN TO AVOID ANY CONFLICT. FILE NAME
      DUPLICATION WILL CAUSE NO PROBLEM ON THE CDC SCOPE OPERATING
      SYSTEM AS SCOPE WILL SIMPLY CATALOG A NEW CYCLE OF THE SAME FILE.
      ON THE OTHER HAND THE CDC NOS SYSTEM IS SIMILAR TO UNIVAC IN THIS
      REGARD AND THE RUN WILL ABORT SINCE THE NAME-CHANGING FEATURE OF
      DMGASP HAS NOT BEEN IMPLEMENTED FOR NOS. QUALIFIER*FILENAME IS THE
      REQUIRED INPUT DATA FORMAT FOR ALL UNIVAC PERMANENT FILE NAMES.
      ON CDC SCOPE, THE QUALIFIER IS INTERPRETED AS THE USERS ID, WHICH
      IN MOST INSTALLATIONS CAN BE SELECTED ALMOST ARBITRARILY. ON CDC
      NOS, THE QUALIFIER IS INTERPRETED AS THE USERS CATALOG NUMBER,
      WHICH IS USUALLY PRESCRIBED BY THE INSTALLATION. A CYCLE NUMBER
      CAN ALSO BE APPENDED TO GIVE THE FORM QUALIFIER*FILENAME(CYCLE)
      ON CDC SCOPE
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                         P R O G R A M     S I Z E

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      ALL ARRAYS REFERRENCED IN THIS CODE THAT ARE PROBLEM DEPENDENT
      RESIDE IN BLANK COMMON. THE SIZE OF BLANK COMMON IS DETERMINED BY
      A PARAMETER STATEMENT IN THE MAIN PROGRAM FOR THE UNIVAC 1100-OS
      VERSION. HENCE A RECOMPILATION IS NECESSARY TO INCREASE OR
      DECREASE CORE ALLOCATION. IN THE CDC 6600 VERSION RECOMPILATION IS
      UNNECESSARY AS THE LENGTH OF BLANK COMMON IS SET BY A FIELD LENGTH
      REQUEST IN THE CONTROL CARD DECK

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      D E F I N I T I O N     O F     I N P U T     P A R A M E T E R S

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      INPUT VARIABLE NAMES GIVEN BELOW ARE GENERALLY THOSE WHICH ARE
      ALSO USED IN THE CODING AND THE VARIABLE TYPES CORRESPOND TO
      STANDARD FORTRAN USAGE.

                     A    -    ALPHANUMERIC
                     E    -    FLOATING POINT
                     F    -    FIXED POINT
                     I    -    INTEGER
                     L    -    LOGICAL

      --------     ----                 -----------
      VARIABLE     TYPE                 DESCRIPTION
      --------     ----                 -----------

      NFILES        I          NUMBER OF RESPONSE FILES THAT MAKE UP THE
                               DESIRED TRANSIENT ANALYSIS DISPLAY. NFILES
                               PRESENTLY CANNOT EXCEED TEN (10)

      NTIMES        I          THE NUMBER OF RESPONSE RECORDS THAT ARE
                               STORED IN ANY PARTICULAR RESPONSE FILE.
                               THESE MUST BE ORDERED CHRONOLOGICALLY FOR
                               INPUT. NTIMES WILL GENERALLY BE THE NUMBER
                               OF TIME STEPS MADE DURING THE TIME THE
                               FILE WAS CREATED EXCEPT IF THE FILE GOES
                               BACK TO TIME EQUAL TO ZERO  IN THIS CASE
                               NTIMES IS EQUAL TO THE NUMBER OF TIME
                               STEPS PLUS ONE TO ACCOUNT FOR THE FIRST
                               RECORD THAT CONTAINS THE INITIAL
                               CONDITIONS

      PRENAM        A          NAME OF PRE-PROCESSED MASS STORAGE FILE
                               CONTAINING ALL FLUID AND STRUCTURE DATA

      XVPNAM        A          NAMES OF RESPONSE FILES THAT MAKE UP A
                               CONTINUOUS SET OF TRANSIENT DATA, ORDERED
                               CHRONOLOGICALLY

      FORWRT        L          TRUE IF PERMANENT FILES DENOTED BY XVPNAM
```

		WERE CREATED USING UNFORMATTED FORTRAN WRITE. OTHERWISE FILES WERE CREATED BY DIRECT TRANSFER USING THE DATA MANAGEMENT SYSTEM DMGASP
DISPLA	L	TRUE IF SELECTED TRANSIENT RESPONSE HISTORIES ARE TO BE DISPLAYED, OTHERWISE FALSE. THIS VARIABLE MUST BE TRUE EVEN IF PSEUDO-VELOCITY SHOCK SPECTRA ARE THE ONLY ONLY OUTPUT DESIRED SINCE STRUCTURAL VELOCITY HISTORIES MUST BE USED FOR THIS COMPUTATION
DEFORM	L	TRUE IF A PERMANENT FILE IS TO BE CREATED THAT CONTAINS A CHRONOLOGICAL SUCCESSION OF RECORDS EACH OF WHICH CONSISTS OF THE COMPLETE DISPLACEMENT FIELD AT SPECIFIC TIMES WITHOUT ANY EXTRANEOUS TIME OR BOOKKEEPING DATA. SUCH A FILE CAN BE IMAGINED AS A SERIES OF SNAPSHOTS OF THE DEFORMED STRUCTURE THROUGHOUT THE SHOCK ANALYSIS. THIS CAPABILITY CANNOT BE USED IF FORWRT IS TRUE
LISTRE	L	TRUE IF TRANSIENT RESPONSE HISTORIES ARE TO BE LISTED IN TABULAR FORM, OTHERWISE FALSE
PRTPLT	L	TRUE IF PRINTER PLOTS ARE TO BE GENERATED FOR TRANSIENT RESPONSE HISTORIES, OTHERWISE FALSE
VECPLT	L	TRUE IF PLOTS ARE TO BE GENERATED FOR TRANSIENT RESPONSE HISTORIES, OTHERWISE FALSE. A PLOT PACKAGE IS NOT PROVIDED WITH THE USA CODE AND IT IS THE USERS RESPONSIBILITY TO COMPLETE THIS FEATURE IN A CALL FROM SUBROUTINE RESSHK IF DESIRED. THE EXISTING CALL USES 'DISPLA' SOFTWARE
NWETHS	I	NUMBER OF STRUCTURAL HISTORIES (EITHER DISPLACEMENTS OR VELOCITIES) TO BE DISPLAYED FOR WHICH THE APPROPRIATE STRUCTURAL FREEDOMS CAN BE IDENTIFIED INTERNALLY THROUGH THE FREEDOM/EQUATION CORRESPONDENCE TABLE. ALL STRUCTURAL NODES WHICH PARTICIPATE IN THE FLUID-STRUCTURE TRANSFORMATION WILL FALL INTO THIS CATEGORY AS WELL AS ANY OTHERS WHOSE GRID POINT COORDIATES WERE ENTERED AS DATA FOR THE FLUID MASS PROCESSOR
NDRYHS	I	NUMBER OF STRUCTURAL HISTORIES (EITHER DISPLACEMENTS OR VELOCITIES) TO BE DISPLAYED FOR WHICH THE APPROPRIATE STRUCTURAL FREEDOMS CANNOT BE IDENTIFIED INTERNALLY THROUGH THE FREEDOM/EQUATION CORRESPONDENCE TABLE. DRY STRUCTURE NODE

		POINTS CAN FALL INTO THIS CATEGORY IF THE USER DID NOT INCLUDE THEM IN THE DATA STREAM FOR THE FLUID MASS PROCESSOR. IN THIS CASE ONE MUST IDENTIFY THE INTERNAL SEQUENCE NUMBER APPROPRIATE TO THE DESIRED DEGREE OF FREEDOM BY A MYSTICAL PROCESS WHICH INVOLVES THE INTIMATE KNOWLEDGE OF THE ELIMINATION ORDER AND ANY REDUCTION OF THE NUMBER OF ACTIVE FREEDOMS DUE TO THE APPLICATION OF CONSTRAINTS. MORAL OF THE STORY - RUN ALL STRUCTURAL GRID POINTS THROUGH THE FLUID MASS PROCESSOR EVEN IF THEY NEVER GET WET
NUMSET	I	NUMBER OF DATA SETS USED TO DEFINE RESPONSE DISPLAYS FOR SEVERAL DEGREES OF FREEDOM THAT DIFFER BY A CONSTANT INCREMENT. THIS FEATURE CAN BE USED TO SIMPLIFY INPUT DATA TO SHOW A NUMBER OF TRANSIENT RESULTS AT DIFFERENT PLACES ALONG A GENERATOR OF A CYLINDER OR, AROUND THE CIRCUMFERENCE AT ANY AXIAL STATION
NODOUT	I	EXTERNAL INDENTIFICATION NUMBER OF STRUCTURAL NODE FOR WHICH A TIME HISTORY DISPLAY IS DESIRED
NFROUT	I	STRUCTURAL DEGREE OF FREEDOM NUMBER FOR WHICH A TIME HISTORY DISPLAY IS DESIRED
NEQHST	I	INTERNAL SEQUENCE NUMBER DETERMINED BY HAND FOR STRUCTURAL DEGREES OF FREEDOM WHICH ARE TO BE DISPLAYED AND ARE NOT INCLUDED IN THE FREEDOM/EQUATION CORRESPONDENCE TABLE FOR REASONS KNOWN ONLY TO THE USER
NODFIR	I	FIRST OF SEVERAL EQUALLY INCREMENTED NODE NUMBERS AT WHICH OUTPUT IS DESIRED
NODLAS	I	LAST OF SEVERAL EQUALLY INCREMENTED NODE NUMBERS AT WHICH OUTPUT IS DESIRED
NODINC	I	INCREMENT TO BE APPLIED IN ASSIGNING NODE NUMBERS FOR OUTPUT
NPREHS	I	NUMBER OF FLUID PRESSURE HISTORIES TO BE DISPLAYED
NEQHPR	I	FLUID CONTROL POINT NUMBER FOR WHICH A TIME HISTORY DISPLAY IS DESIRED FOR THE TOTAL PRESSURE
SCALEF	L	TRUE IF MULTIPLICATIVE CONSTANT FACTORS ARE TO BE APPLIED TO THE DISPLAYED VALUES OF THE STRUCTURAL DISPLACEMENTS AND VELOCITIES, TOTAL FLUID PRESSURES AND/OR TIME, OTHERWISE FALSE. SUCH FACTORS ARE

```
                                NOT APPLIED TO THE PERMANENT FILES
                                CONTAINING THE RESPONSE HISTORIES

      RESFAC        E,F         MULTIPLICATIVE LENGTH CONVERSION FACTOR TO
                                BE APPLIED TO THE DISPLAYED VALUES OF THE
                                STRUCTURAL DISPLACEMENT AND VELOCITY
                                HISTORIES

      PREFAC        E,F         MULTIPLICATIVE PRESSURE CONVERSION FACTOR
                                TO BE APPLIED TO THE DISPLAYED VALUES OF
                                THE TOTAL PRESSURE HISTORIES

      TIMFAC        E,F         MULTIPLICATIVE TIME CONVERSION FACTOR TO
                                BE APPLIED TO THE DISPLAYED VALUES OF THE
                                TIME AXIS FOR ALL THE TRANSIENT RESPONSE
                                HISTORIES

      SHSPEC        L           TRUE IF PSEUDO-VELOCITY SHOCK SPECTRA ARE
                                ALSO DESIRED FOR STRUCTURAL FREEDOMS WHOSE
                                VELOCITY RESPONSE IS TO BE DISPLAYED,
                                OTHERWISE FALSE

      SHLIST        L           TRUE IF PSEUDO-VELOCITY SHOCK SPECTRA ARE
                                TO BE LISTED IN TABULAR FORM, OTHERWISE
                                FALSE

      SHPRPL        L           TRUE IF PRINTER PLOTS ARE TO BE GENERATED
                                FOR PSEUDO-VELOCITY SHOCK SPECTRA,
                                OTHERWISE FALSE

      SHVCPL        L           TRUE IF VECTOR PLOTS ARE TO BE GENERATED
                                FOR PSEUDO-VELOCITY SHOCK SPECTRA,
                                OTHERWISE FALSE (SEE VECPLT)

      FREQLW        E,F         LOWER LIMIT OF FREQUENCY RANGE TO BE
                                SCANNED FOR PSEUDO-VELOCITY SHOCK SPECTRA

      FREQUP        E,F         UPPER LIMIT OF FREQUENCY RANGE TO BE
                                SCANNED FOR PSEUDO-VELOCITY SHOCK SPECTRA

      DFREQ         E,F         FREQUENCY INCREMENT TO BE USED IN
                                GENERATING PSEUDO-VELOCITY SHOCK SPECTRA

      SNPNAM        A           NAME OF PERMANENT FILE TO BE CREATED
                                CONTAINING STRUCTURAL SNAPSHOT DATA

      NSNAP         I           NUMBER OF TIMES FOR WHICH THE DISPLACEMENT
                                FIELD IS TO BE WRITTEN ON THE PERMANENT
                                FILE DENOTED BY SNPNAM

      PRTDIS        L           TRUE IF STRUCTURAL DISPLACEMENT FIELD IS
                                TO BE PRINTED FOR EACH SNAPSHOT, OTHERWISE
                                FALSE

      TIME          E,F         TIME AT WHICH SNAPSHOT IS DESIRED, MUST BE
                                ORDERED CHRONOLOGICALLY

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                 I N P U T    D A T A    C A R D    D E C K

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ALL INPUT DATA EXCEPT ALPHANUMERIC DATA MUST BE RIGHT JUSTIFIED
IN EIGHT (8) COLUMN FIELDS WHICH CAN OCCUPY THE ENTIRE CARD.
ALPHANUMERIC DATA MUST BE LEFT JUSTIFIED IN TWENTY (20) COLUMN
FIELDS. FILE NAME PLUS QUALIFIER IS CURRENTLY RESTRICTED TO
EIGHTEEN (18) CHARACTERS FOR UNIVAC OPERATION WHILE NINETEEN (19)
CHARACTERS MAY BE USED FOR CDC OPERATION

TASK DEFINITION (MAIN PROGRAM POSTPR):
--------------------------------------

72 COLUMN ALPHNUMERIC TITLE, ONLY THE FIRST 48 WILL APPEAR ON PLOTS
NFILES
NTIMES(I), I=1,NFILES
PRENAM
XVPNAM(I), I=1,NFILES
FORWRT  DISPLA  DEFORM

TRANSIENT RESPONSE DISPLAY (SUBROUTINE RESSHK):
-----------------------------------------------

IF DISPLA = .FALSE. SKIP ALL INPUT FROM HERE TO SUBROUTINE SNAPPY

LISTRE  PRTPLT  VECPLT

TRANSIENT RESPONSE DISPLAY (SUBROUTINE STRDSP):
-----------------------------------------------

NWETHS  NDRYHS  NUMSET                       )
NODOUT  NFROUT          )                    )
   .       .            )   TOTAL = NWETHS   )
   .       .            )                    )
NODOUT  NFROUT  NEQHST  )                    )   THIS SET FOR
   .       .       .    )   TOTAL = NDRYHS   )
   .       .       .    )                    )   DISPLACEMENTS
                                             )
IF NUMSET = 0 OMIT THE FOLLOWING CARD        )
                                             )
NFROUT  NODFIR  NODLAS  NODINC               )

NWETHS  NDRYHS  NUMSET                       )
NODOUT  NFROUT          )                    )
   .       .            )   TOTAL = NWETHS   )
   .       .            )                    )
NODOUT  NFROUT  NEQHST  )                    )   THIS SET FOR
   .       .       .    )   TOTAL = NDRYHS   )
   .       .       .    )                    )   VELOCITIES
                                             )
IF NUMSET = 0 OMIT THE FOLLOWING CARD        )
                                             )
NFROUT  NODFIR  NODLAS  NODINC               )

TRANSIENT RESPONSE DISPLAY (SUBROUTINE RESSHK):
-----------------------------------------------
```

```
NPREHS  NUMSET
NEQHPR                  )
                        )   TOTAL = NPREHS
                        )

IF NUMSET = 0 OMIT THE FOLLOWING CARD

NODFIR  NODLAS  NODINC

TRANSIENT RESPONSE DISPLAY (SUBROUTINE FILBUF):
-----------------------------------------------

SCALEF

IF SCALEF = .TRUE. READ THE FOLLOWING CARD

RESFAC  PREFAC  TIMFAC

PSEUDO-VELOCITY SHOCK SPECTRA (SUBROUTINE RESSHK):
--------------------------------------------------

SHSPEC

IF SHSPEC = .TRUE. READ THE FOLLOWING CARDS

SHLIST  SHPRPL  SHVCPL
FREQLW  FREQUP  DFREQ

SNAPSHOT FILE CREATION (SUBROUTINE SNAPPY):
-------------------------------------------

IF DEFORM = .FALSE. THIS TERMINATES THE INPUT DATA DECK

SNPNAM
NSNAP
PRTDIS
TIME          )
              )   TOTAL = NSNAP
              )
```

The following discussion is provided as an aid to user understanding of the sample output that is included here.

The input deck shown on the next page requests vector plots for both the transient response histories and pseudo-velocity shock spectra. This is appropriate if the DISSPLA plot package is available at the users installation. Otherwise appropriate modifications must either be made to use a different plot package or the input deck should be modified. In any case the printer plot package is resident in USA -STAGS.

The format used for listing the pseudo-velocity shock spectra is similar to that used for the display of the transient response histories shown in Appendix E except that the first row is now frequency rather than time.

The following input and output for the infinite circular cylindrical shell problem contain some minor differences due to the fact that the input is appropriate to the standard CDC or UNIVAC USA-STAGS version 3 whereas the output is from the VAX virtual memory machine. The basic reason for this is that the VAX version does not explicitly process the fluid equation system in a multi-block, out-of-core mode in contrast to the CDC and UNIVAC versions. In addition, permanent file naming conventions differ slightly; however it is anticipated that these differences should not prove to be a difficulty for the user.

```
INFINITE CYLINDER, PLANE STEP WAVE
       1
      91
CYL*PREP
CYL*POST
       F        T        F
       T        T        T
       2        0        0
      10        3
      10        2
       4        0        0
       1        3
      19        3
      10        2
      19        3
       3        0
       1
      10
      19
       F
       1        0
       T
       T        T        T
      0.       3.     .025
```

INFINITE CYLINDER, PLANE STEP WAVE

```
+++  OPEN,  16 = DIRTY:CYL.PRE          , Acc= DIRECT , Stat= OLD
+++  CLOSE, 16
+++  OPEN,  12 = DIRTY:CYL.POS          , Acc= DIRECT , Stat= OLD
+++  CLOSE, 12
```

TRANSIENT RESPONSE HISTORIES:

		1	2	3	4	5	6	7	8	9	10
	T	0.00000E+00	0.25000E-01	0.50000E-01	0.75000E-01	0.10000E+00	0.12500E+00	0.15000E+00	0.17500E+00	0.20000E+00	0.22500E+00
10/3	D	0.00000E+00	-0.12200E-05	-0.74684E-05	-0.23222E-04	-0.50250E-04	-0.86229E-04	-0.12524E-03	-0.15897E-03	-0.17775E-03	-0.17111E-03
10/2	D	0.00000E+00	0.27946E-08	0.28548E-07	0.14705E-06	0.51685E-06	0.14126E-05	0.32386E-05	0.65662E-05	0.12312E-04	0.22358E-04
1/3	V	0.00000E+00	-0.27830E+00	-0.72955E+00	-0.10586E+01	-0.12946E+01	-0.14646E+01	-0.15883E+01	-0.16793E+01	-0.17468E+01	-0.17971E+01
10/3	V	0.00000E+00	-0.97600E-04	-0.40227E-03	-0.85804E-03	-0.13042E-02	-0.15740E-02	-0.15469E-02	-0.11517E-02	-0.35029E-03	0.88132E-03
10/2	V	0.00000E+00	0.22357E-06	0.18367E-05	0.76435E-05	0.21940E-04	0.49719E-04	0.96365E-04	0.16984E-03	0.28983E-03	0.51388E-03
19/3	V	0.00000E+00	-0.48206E-04	-0.19742E-03	-0.41794E-03	-0.63015E-03	-0.75254E-03	-0.72692E-03	-0.52096E-03	-0.11950E-03	0.48358E-03
1/0	P	0.11765E+00	0.16339E+01	0.12203E+01	0.[illegible]905E+00	0.67930E+00	0.53466E+00	0.44023E+00	0.37910E+00	0.34005E+00	0.31600E+00
10/0	P	0.00000E+00	0.61501E-03	0.13112E-02	0.15903E-02	0.12989E-02	0.55402E-03	-0.47723E-03	-0.16613E-02	-0.29301E-02	-0.42472E-02
19/0	P	0.00000E+00	0.30375E-03	0.63956E-03	0.76422E-03	0.60985E-03	0.23282E-03	-0.28114E-03	-0.86254E-03	-0.14824E-02	-0.21231E-02

		11	12	13	14	15	16	17	18	19	20
	T	0.25000E+00	0.27500E+00	0.30000E+00	0.32500E+00	0.35000E+00	0.37500E+00	0.40000E+00	0.42500E+00	0.45000E+00	0.47500E+00
10/3	D	-0.12824E-03	-0.38131E-04	0.11095E-03	0.33286E-03	0.64611E-03	0.10774E-02	0.16658E-02	0.24671E-02	0.35567E-02	0.50289E-02
10/2	D	0.41273E-04	0.80347E-04	0.16579E-03	0.35305E-03	0.74836E-03	0.15353E-02	0.29397E-02	0.55406E-02	0.96532E-02	0.15873E-01
1/3	V	-0.18348E+01	-0.18633E+01	-0.18852E+01	-0.19020E+01	-0.19150E+01	-0.19250E+01	-0.19328E+01	-0.19391E+01	-0.19442E+01	-0.19484E+01
10/3	V	0.25484E-02	0.45603E-02	0.72661E-02	0.10487E-01	0.14574E-01	0.19931E-01	0.27141E-01	0.36961E-01	0.50207E-01	0.67569E-01
10/2	V	0.99926E-03	0.21267E-02	0.47085E-02	0.10273E-01	0.21351E-01	0.41603E-01	0.75548E-01	0.12773E+00	0.20128E+00	0.29632E+00
19/3	V	0.12814E-02	0.22581E-02	0.33950E-02	0.46717E-02	0.60701E-02	0.75660E-02	0.91321E-02	0.10746E-01	0.12389E-01	0.14043E-01
1/0	P	0.30265E+00	0.29674E+00	0.29607E+00	0.29894E+00	0.30425E+00	0.31144E+00	0.31984E+00	0.32892E+00	0.33826E+00	0.34771E+00
10/0	P	-0.54631E-02	-0.65645E-02	-0.74057E-02	-0.78132E-02	-0.75270E-02	-0.59570E-02	-0.26023E-02	0.31738E-02	0.12037E-01	0.24399E-01
19/0	P	-0.27315E-02	-0.33140E-02	-0.38574E-02	-0.43731E-02	-0.48708E-02	-0.53121E-02	-0.57207E-02	-0.61111E-02	-0.64931E-02	-0.68676E-02

		21	22	23	24	25	26	27	28	29	30
	T	0.50000E+00	0.52500E+00	0.55000E+00	0.57500E+00	0.60000E+00	0.62500E+00	0.65000E+00	0.67500E+00	0.70000E+00	0.72500E+00
10/3	D	0.69913E-02	0.95550E-02	0.12822E-01	0.16871E-01	0.21752E-01	0.27485E-01	0.34063E-01	0.41470E-01	0.49688E-01	0.58710E-01
10/2	D	0.24687E-01	0.36427E-01	0.51189E-01	0.68813E-01	0.88939E-01	0.11113E+00	0.13500E+00	0.16033E+00	0.18709E+00	0.21537E+00
1/3	V	-0.19519E+01	-0.19545E+01	-0.19565E+01	-0.19581E+01	-0.19594E+01	-0.19606E+01	-0.19619E+01	-0.19630E+01	-0.19640E+01	-0.19648E+01
10/3	V	0.89425E-01	0.11567E+00	0.14565E+00	0.17827E+00	0.21224E+00	0.24637E+00	0.27990E+00	0.31264E+00	0.34482E+00	0.37695E+00
10/2	V	0.40877E+00	0.53040E+00	0.65059E+00	0.75938E+00	0.85070E+00	0.92430E+00	0.98528E+00	0.10415E+01	0.10996E+01	0.11625E+01
19/3	V	0.15689E-01	0.17310E-01	0.18886E-01	0.20399E-01	0.21833E-01	0.23179E-01	0.24449E-01	0.25686E-01	0.26982E-01	0.28509E-01
1/0	P	0.35727E+00	0.36690E+00	0.37657E+00	0.38611E+00	0.39535E+00	0.40422E+00	0.41267E+00	0.42089E+00	0.42893E+00	0.43675E+00
10/0	P	0.40271E-01	0.59138E-01	0.80147E-01	0.10204E+00	0.12358E+00	0.14387E+00	0.16195E+00	0.17792E+00	0.19187E+00	0.20422E+00
19/0	P	-0.72324E-02	-0.75914E-02	-0.79253E-02	-0.82302E-02	-0.84876E-02	-0.86540E-02	-0.87115E-02	-0.85390E-02	-0.80027E-02	-0.68653E-02

		31	32	33	34	35	36	37	38	39	40
	T	0.75000E+00	0.77500E+00	0.80000E+00	0.82500E+00	0.85000E+00	0.87500E+00	0.90000E+00	0.92500E+00	0.95000E+00	0.97500E+00
10/3	D	0.68541E-01	0.79196E-01	0.90699E-01	0.10308E+00	0.11640E+00	0.13069E+00	0.14603E+00	0.16241E+00	0.17943E+00	0.19640E+00
10/2	D	0.24525E+00	0.27677E+00	0.30983E+00	0.34430E+00	0.38008E+00	0.41711E+00	0.45544E+00	0.49514E+00	0.53522E+00	0.57863E+00
1/3	V	-0.19656E+01	-0.19668E+01	-0.19686E+01	-0.19711E+01	-0.19741E+01	-0.19776E+01	-0.19813E+01	-0.19853E+01	-0.19898E+01	-0.19949E+01
10/3	V	0.40951E+00	0.44287E+00	0.47738E+00	0.51347E+00	0.55151E+00	0.59196E+00	0.63547E+00	0.67459E+00	0.68711E+00	0.67058E+00
10/2	V	0.12283E+01	0.12927E+01	0.13521E+01	0.14058E+01	0.14562E+01	0.15067E+01	0.15599E+01	0.16155E+01	0.16708E+01	0.17223E+01
19/3	V	0.30558E-01	0.33565E-01	0.38156E-01	0.45111E-01	0.55399E-01	0.70028E-01	0.89940E-01	0.11581E+00	0.14783E+00	0.18557E+00
1/0	P	0.44414E+00	0.45086E+00	0.45677E+00	0.46190E+00	0.46644E+00	0.47059E+00	0.47447E+00	0.47801E+00	0.48104E+00	0.48342E+00
10/0	P	0.21524E+00	0.22466E+00	0.23182E+00	0.23594E+00	0.23805E+00	0.23734E+00	0.23414E+00	0.27925E+00	0.41465E+00	0.47416E+00
19/0	P	-0.47841E-02	-0.12695E-02	0.43246E-02	0.12773E-01	0.24945E-01	0.41650E-01	0.63523E-01	0.90840E-01	0.12335E+00	0.16017E+00

		41	42	43	44	45	46	47	48	49	50

```
      T 0.10000E+01 0.10500E+01 0.11000E+01 0.11500E+01 0.12000E+01 0.12500E+01 0.13000E+01 0.13500E+01 0.14000E+01 0.14500E+01
 10/3 D 0.21246E+00 0.23923E+00 0.25785E+00 0.26807E+00 0.27113E+00 0.26905E+00 0.26328E+00 0.25499E+00 0.24517E+00 0.23464E+00
 10/2 D 0.62226E+00 0.71268E+00 0.80700E+00 0.90491E+00 0.10056E+01 0.11075E+01 0.12086E+01 0.13071E+01 0.14011E+01 0.14894E+01
  1/3 V-0.20006E+01-0.20130E+01-0.20254E+01-0.20366E+01-0.20478E+01-0.20591E+01-0.20693E+01-0.20775E+01-0.20844E+01-0.20914E+01
 10/3 V 0.61410E+00 0.45669E+00 0.28816E+00 0.12049E+00 0.18327E-02-0.84766E-01-0.14612E+00-0.18562E+00-0.20684E+00-0.21445E+00
 10/2 V 0.17681E+01 0.18487E+01 0.19242E+01 0.19923E+01 0.20351E+01 0.20395E+01 0.20055E+01 0.19337E+01 0.18271E+01 0.17060E+01
 19/3 V 0.22787E+00 0.32514E+00 0.41575E+00 0.48412E+00 0.54121E+00 0.59306E+00 0.64463E+00 0.69533E+00 0.74231E+00 0.78542E+00
  1/0 P 0.48514E+00 0.48770E+00 0.49086E+00 0.49474E+00 0.49842E+00 0.50157E+00 0.50589E+00 0.50977E+00 0.51511E+00 0.51992E+00
 10/0 P 0.67733E+00 0.63492E+00 0.73815E+00 0.65764E+00 0.61760E+00 0.59809E+00 0.59183E+00 0.59729E+00 0.61310E+00 0.63636E+00
 19/0 P 0.19980E+00 0.27869E+00 0.34637E+00 0.39752E+00 0.43491E+00 0.46611E+00 0.49614E+00 0.52419E+00 0.54739E+00 0.56553E+00

           51          52          53          54          55          56          57          58          59          60
      T 0.15000E+01 0.15500E+01 0.16000E+01 0.16500E+01 0.17000E+01 0.17500E+01 0.18000E+01 0.18500E+01 0.19000E+01 0.19500E+01
 10/3 D 0.22393E+00 0.21327E+00 0.20259E+00 0.19164E+00 0.18021E+00 0.16827E+00 0.15595E+00 0.14345E+00 0.13089E+00 0.11831E+00
 10/2 D 0.15722E+01 0.16512E+01 0.17288E+01 0.18065E+01 0.18849E+01 0.19628E+01 0.20390E+01 0.21129E+01 0.21857E+01 0.22587E+01
  1/3 V-0.20995E+01-0.21080E+01-0.21159E+01-0.21215E+01-0.21225E+01-0.21155E+01-0.20970E+01-0.20652E+01-0.20225E+01-0.19752E+01
 10/3 V-0.21413E+00-0.21237E+00-0.21479E+00-0.22303E+00-0.23416E+00-0.24361E+00-0.24897E+00-0.25100E+00-0.25162E+00-0.25159E+00
 10/2 V 0.16062E+01 0.15538E+01 0.15474E+01 0.15633E+01 0.15707E+01 0.15477E+01 0.14993E+01 0.14582E+01 0.14520E+01 0.14697E+01
 19/3 V 0.82766E+00 0.87038E+00 0.91413E+00 0.95553E+00 0.99617E+00 0.10386E+01 0.10842E+01 0.11328E+01 0.11855E+01 0.12475E+01
  1/0 P 0.52368E+00 0.52741E+00 0.53266E+00 0.54122E+00 0.55547E+00 0.57819E+00 0.61181E+00 0.65652E+00 0.70865E+00 0.76096E+00
 10/0 P 0.66173E+00 0.68437E+00 0.69997E+00 0.70775E+00 0.71154E+00 0.71599E+00 0.72310E+00 0.73162E+00 0.73921E+00 0.74481E+00
 19/0 P 0.59095E+00 0.59585E+00 0.60895E+00 0.61803E+00 0.62406E+00 0.62842E+00 0.63143E+00 0.63069E+00 0.62469E+00 0.60854E+00

           61          62          63          64          65          66          67          68          69          70
      T 0.20000E+01 0.21000E+01 0.22000E+01 0.23000E+01 0.24000E+01 0.25000E+01 0.26000E+01 0.27000E+01 0.28000E+01 0.29000E+01
 10/3 D 0.10577E+00 0.81803E-01 0.60596E-01 0.43010E-01 0.29100E-01 0.18356E-01 0.93135E-02 0.48520E-03-0.80781E-02-0.15453E-01
 10/2 D 0.23324E+01 0.24801E+01 0.26325E+01 0.27985E+01 0.29804E+01 0.31721E+01 0.33658E+01 0.35546E+01 0.37383E+01 0.39237E+01
  1/3 V-0.19310E+01-0.18640E+01-0.18414E+01-0.18273E+01-0.18039E+01-0.18077E+01-0.18300E+01-0.18344E+01-0.18222E+01-0.18206E+01
 10/3 V-0.24972E+00-0.22971E+00-0.19444E+00-0.15727E+00-0.12094E+00-0.93940E-01-0.86908E-01-0.89657E-01-0.81608E-01-0.65886E-01
 10/2 V 0.14773E+01 0.14767E+01 0.15705E+01 0.17511E+01 0.18867E+01 0.19461E+01 0.19284E+01 0.18478E+01 0.18251E+01 0.18829E+01
 19/3 V 0.13092E+01 0.13857E+01 0.14146E+01 0.14242E+01 0.14262E+01 0.14370E+01 0.14617E+01 0.15033E+01 0.15585E+01 0.16143E+01
  1/0 P 0.80474E+00 0.85211E+00 0.86783E+00 0.87730E+00 0.88971E+00 0.89062E+00 0.87826E+00 0.87268E+00 0.87976E+00 0.88503E+00
 10/0 P 0.74787E+00 0.75995E+00 0.78324E+00 0.81402E+00 0.84698E+00 0.87296E+00 0.88300E+00 0.88216E+00 0.88521E+00 0.89536E+00
 19/0 P 0.63766E+00 0.71377E+00 0.74853E+00 0.76429E+00 0.77327E+00 0.78563E+00 0.81098E+00 0.85252E+00 0.90670E+00 0.95946E+00

           71          72          73          74          75          76          77          78          79          80
      T 0.30000E+01 0.31000E+01 0.32000E+01 0.33000E+01 0.34000E+01 0.35000E+01 0.36000E+01 0.37000E+01 0.38000E+01 0.39000E+01
 10/3 D-0.21583E-01-0.26946E-01-0.31417E-01-0.34489E-01-0.36088E-01-0.37083E-01-0.38725E-01-0.41200E-01-0.43730E-01-0.45945E-01
 10/2 D 0.41112E+01 0.42918E+01 0.44609E+01 0.46221E+01 0.47789E+01 0.49338E+01 0.50911E+01 0.52547E+01 0.54231E+01 0.55910E+01
  1/3 V-0.18230E+01-0.18147E+01-0.18142E+01-0.18282E+01-0.18309E+01-0.18129E+01-0.17834E+01-0.17413E+01-0.16981E+01-0.16857E+01
 10/3 V-0.56714E-01-0.50549E-01-0.38866E-01-0.22572E-01-0.94119E-02-0.10496E-01-0.22347E-01-0.27149E-01-0.23453E-01-0.20843E-01
 10/2 V 0.18682E+01 0.17446E+01 0.16366E+01 0.15864E+01 0.15515E+01 0.15461E+01 0.15995E+01 0.16725E+01 0.16947E+01 0.16642E+01
 19/3 V 0.16447E+01 0.16423E+01 0.16284E+01 0.16260E+01 0.16391E+01 0.16501E+01 0.16433E+01 0.16301E+01 0.16312E+01 0.16443E+01
  1/0 P 0.88551E+00 0.88844E+00 0.88966E+00 0.88641E+00 0.89068E+00 0.91067E+00 0.94286E+00 0.98239E+00 0.10171E+01 0.10268E+01
 10/0 P 0.90497E+00 0.91228E+00 0.92237E+00 0.93802E+00 0.95359E+00 0.95825E+00 0.95158E+00 0.94559E+00 0.94651E+00 0.95158E+00
 19/0 P 0.98903E+00 0.98637E+00 0.96595E+00 0.95147E+00 0.95347E+00 0.96032E+00 0.95564E+00 0.94186E+00 0.93482E+00 0.93967E+00

           81          82          83          84          85          86          87          88          89          90
      T 0.40000E+01 0.41000E+01 0.42000E+01 0.43000E+01 0.44000E+01 0.45000E+01 0.46000E+01 0.47000E+01 0.48000E+01 0.49000E+01
 10/3 D-0.47842E-01-0.49326E-01-0.50615E-01-0.51914E-01-0.52936E-01-0.53782E-01-0.55296E-01-0.57776E-01-0.60327E-01-0.62096E-01
 10/2 D 0.57581E+01 0.59311E+01 0.61134E+01 0.62996E+01 0.64833E+01 0.66630E+01 0.68384E+01 0.70110E+01 0.71833E+01 0.73543E+01
```

```
 1/3 V-0.17076E+01-0.17360E+01-0.17580E+01-0.17641E+01-0.17474E+01-0.17263E+01-0.17285E+01-0.17465E+01-0.17576E+01-0.17511E+01
10/3 V-0.17097E-01-0.12589E-01-0.13194E-01-0.12773E-01-0.76704E-02-0.92522E-02-0.21027E-01-0.28581E-01-0.22423E-01-0.12957E-01
10/2 V 0.16780E+01 0.17808E+01 0.18662E+01 0.18575E+01 0.18169E+01 0.17769E+  0.17315E+01 0.17203E+01 0.17257E+01 0.16947E+01
19/3 V 0.16511E+01 0.16479E+01 0.16553E+01 0.16776E+01 0.16942E+01 0.17029E+01 0.17235E+01 0.17491E+01 0.17569E+01 0.17479E+01
 1/0 P 0.10076E+01 0.97800E+00 0.95670E+00 0.95354E+00 0.96907E+00 0.98644E+00 0.98473E+00 0.96610E+00 0.94993E+00 0.94682E+00
10/0 P 0.95908E+00 0.96669E+00 0.97138E+00 0.97555E+00 0.98066E+00 0.98068E+00 0.97252E+30 0.96502E+00 0.96802E+00 0.97787E+00
19/0 P 0.94567E+00 0.94383E+00 0.94608E+00 0.95932E+00 0.97372E+00 0.98396E+00 0.99812E+00 0.10149E+01 0.10212E+01 0.10117E+01

            91
     T 0.50000E+01
10/3 D-0.63325E-01
10/2 D 0.75225E+01
 1/3 V-0.17631E+01
10/3 V-0.11638E-01
10/2 V 0.16685E+01
19/3 V 0.17550E+01
 1/0 P 0.95402E+00
10/0 P 0.98446E+00
19/0 P 0.99407E+00
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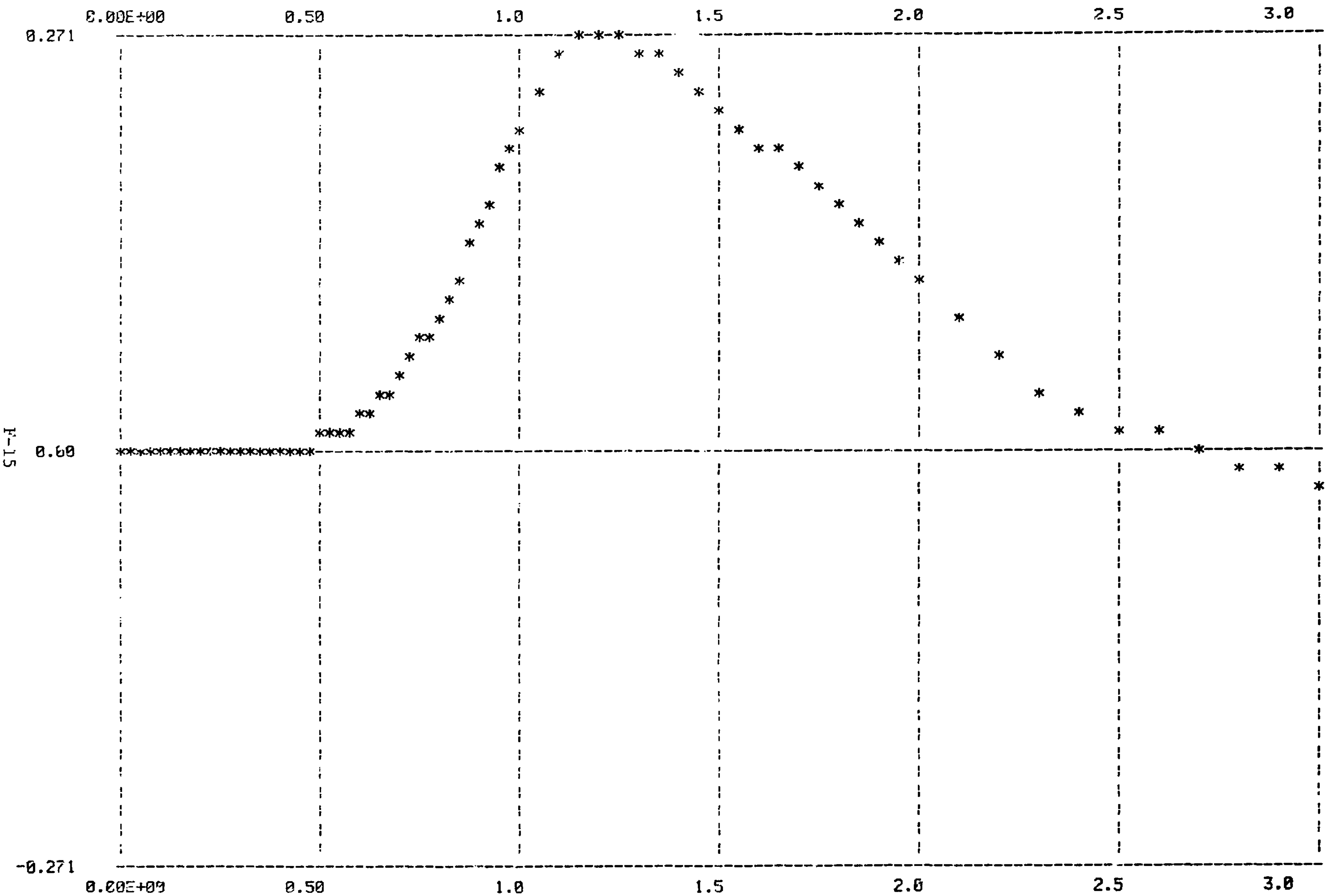
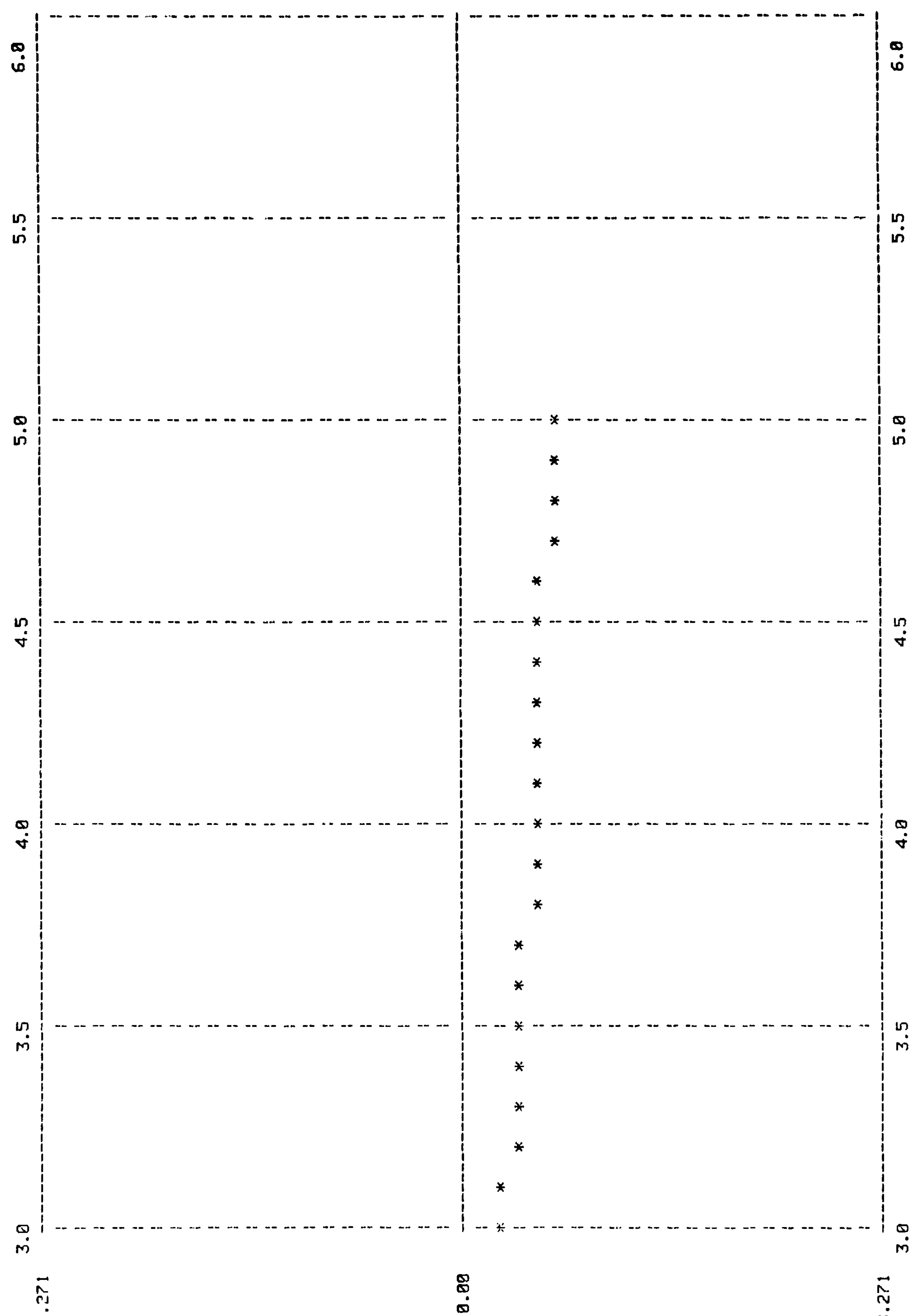
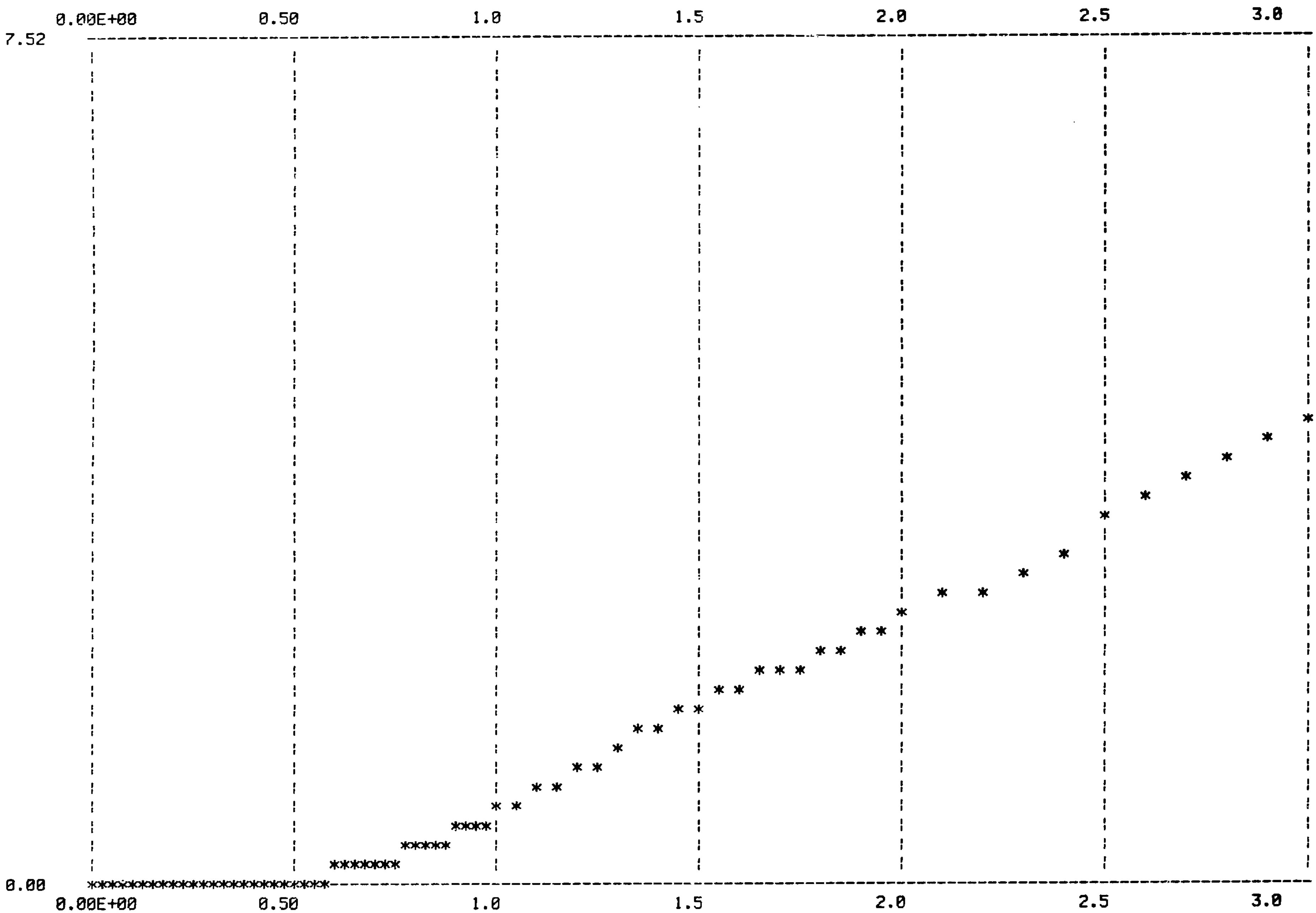
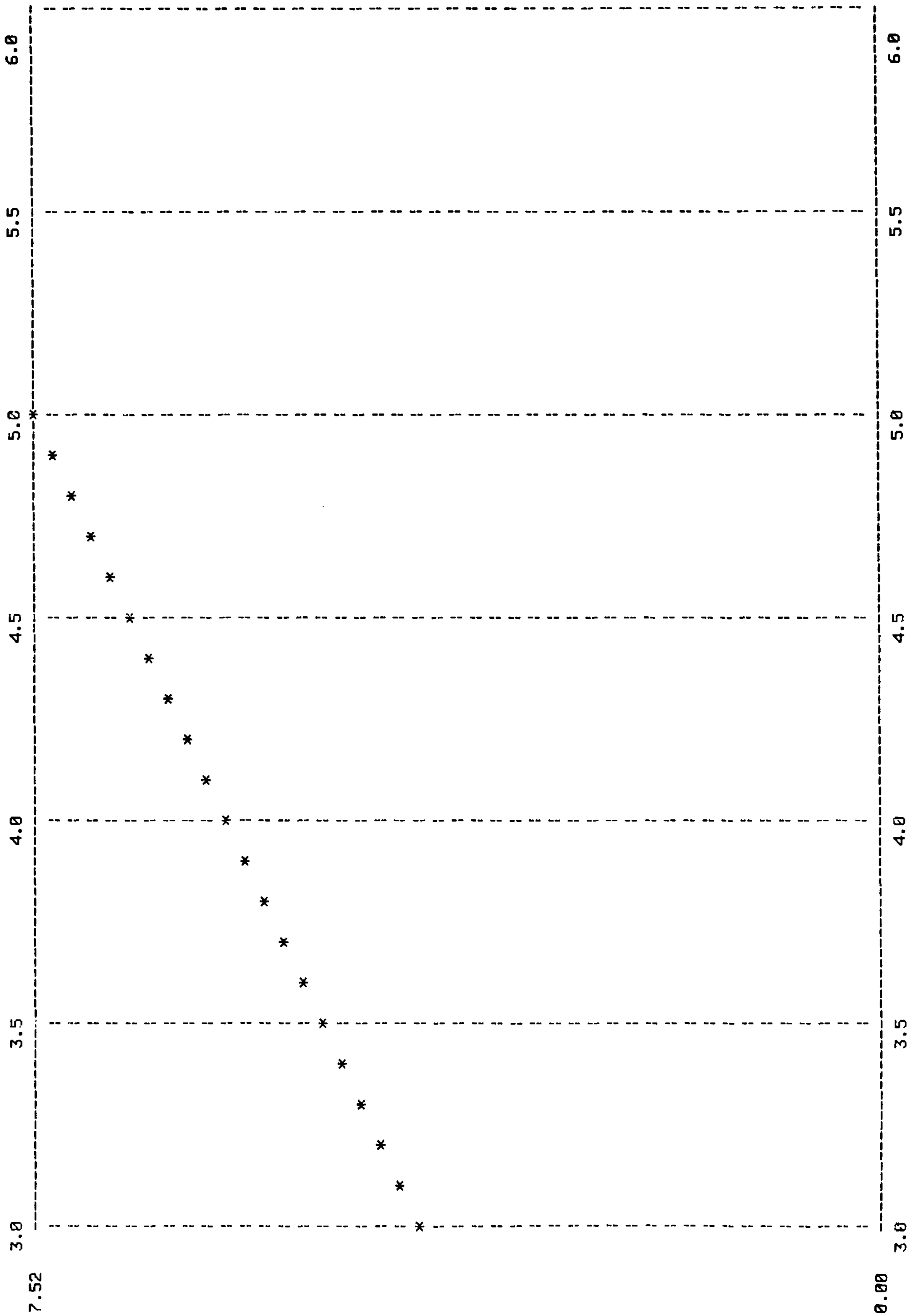
DISPLACEMENT RESPONSE OF STRUCTURAL NODE 18, FREEDOM NUMBER 3:




6.0
5.5
5.0
4.5
4.0
3.5
3.0
0.271
0.00
-0.271

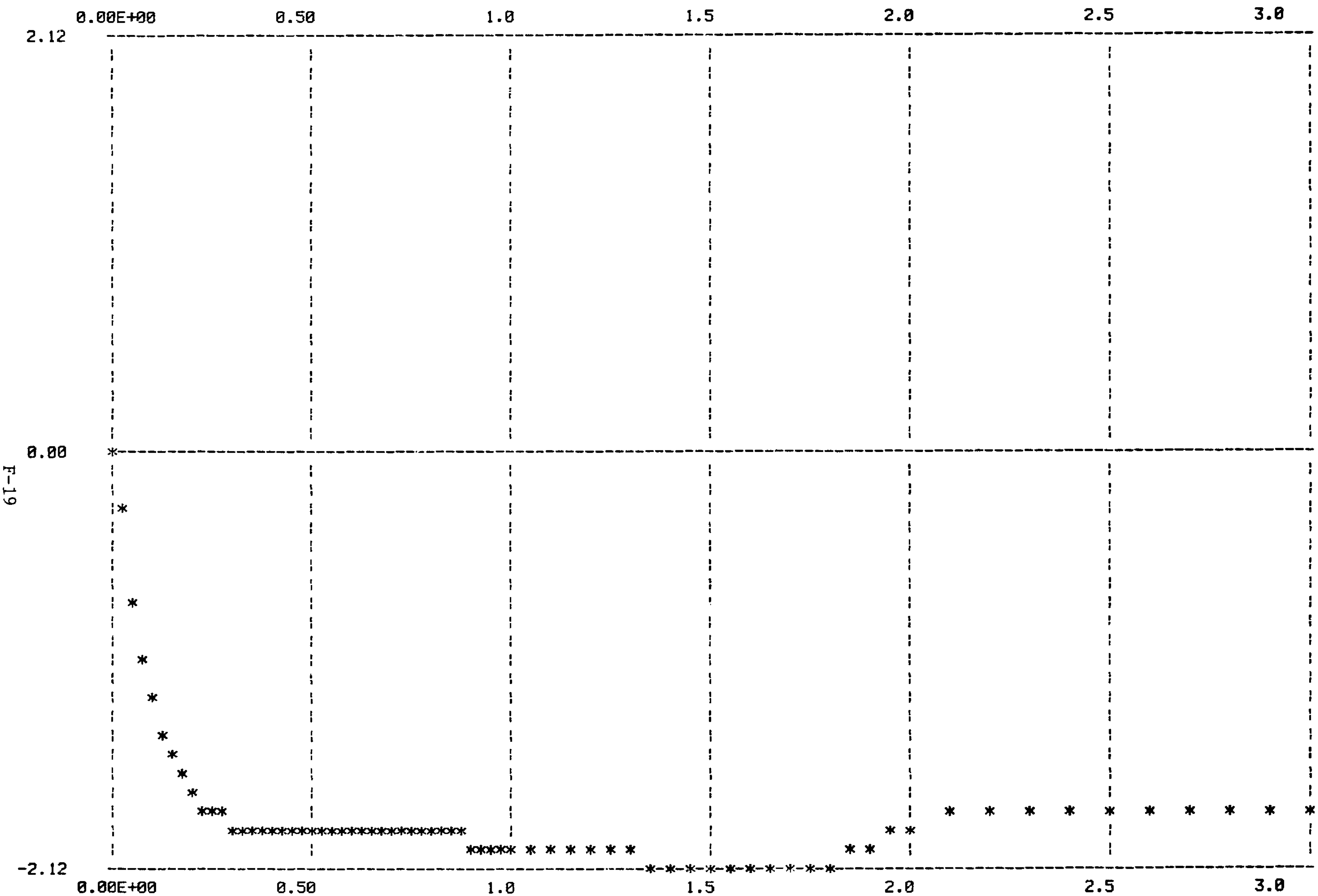
DISPLACEMENT RESPONSE OF STRUCTURAL NODE 10, FREEDOM NUMBER 2:

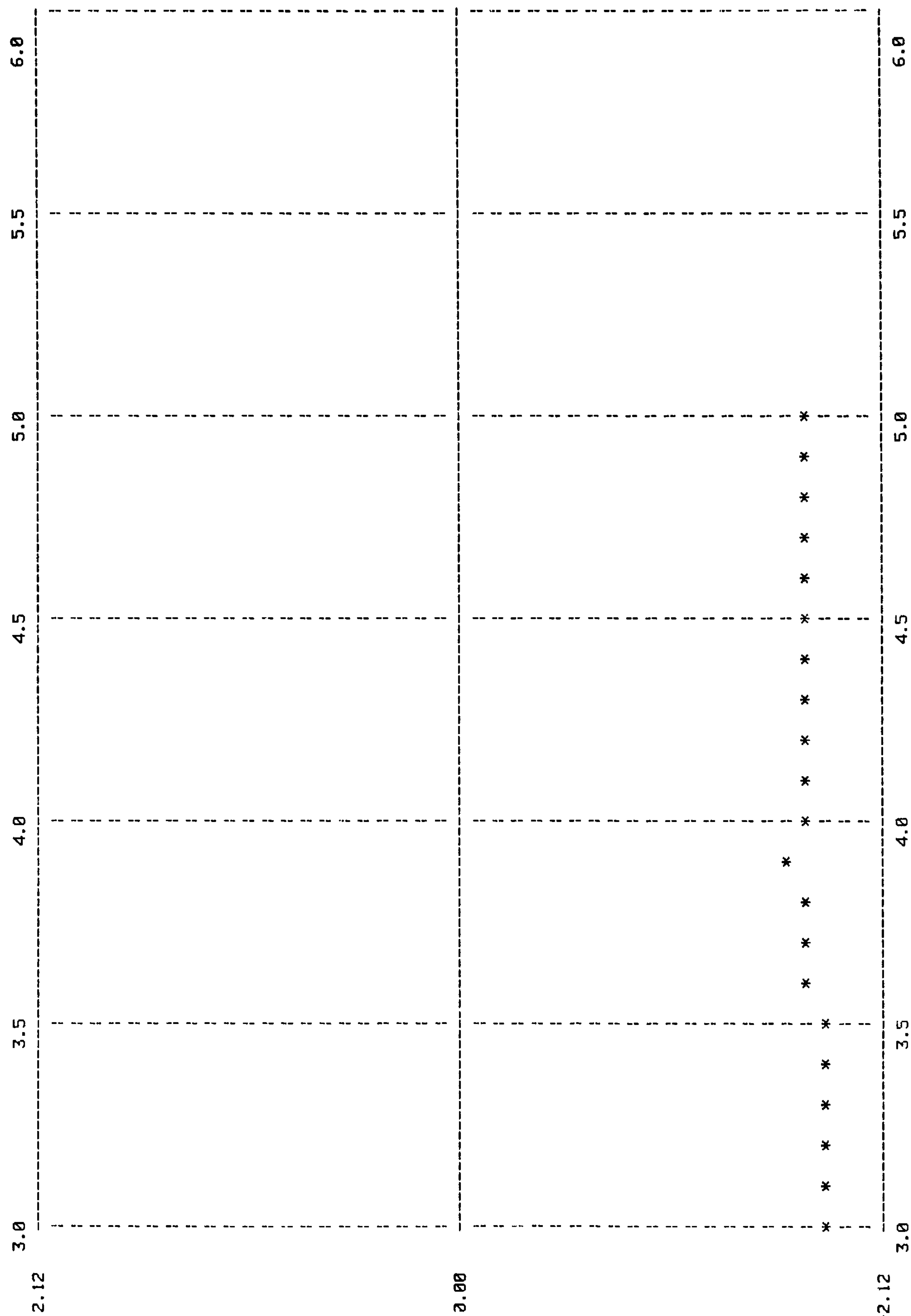




6.0
5.5
5.0
4.5
4.0
3.5
3.0
7.52
0.00

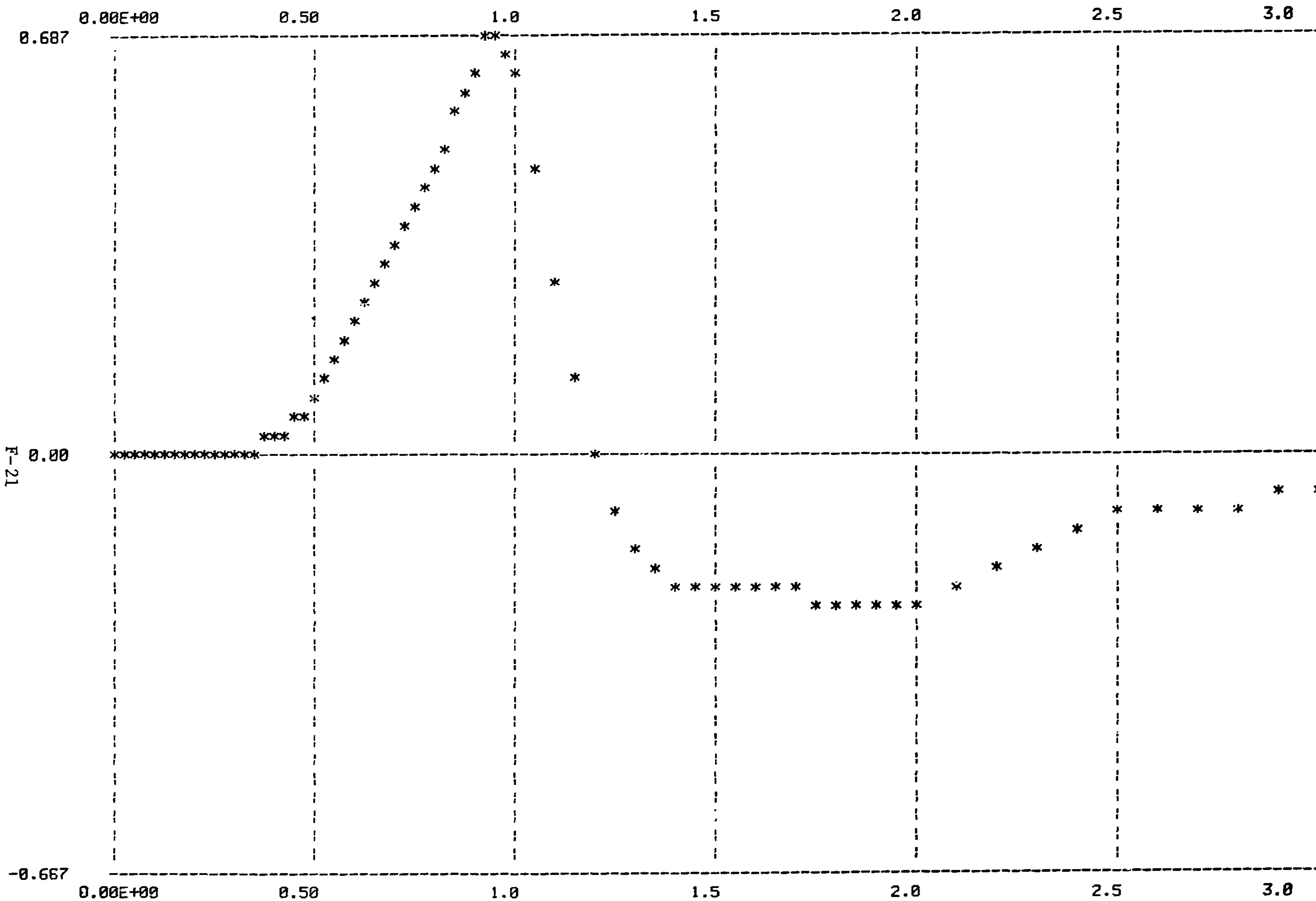
VELOCITY RESPONSE OF STRUCTURAL NODE 1, FREEDOM NUMBER 3:

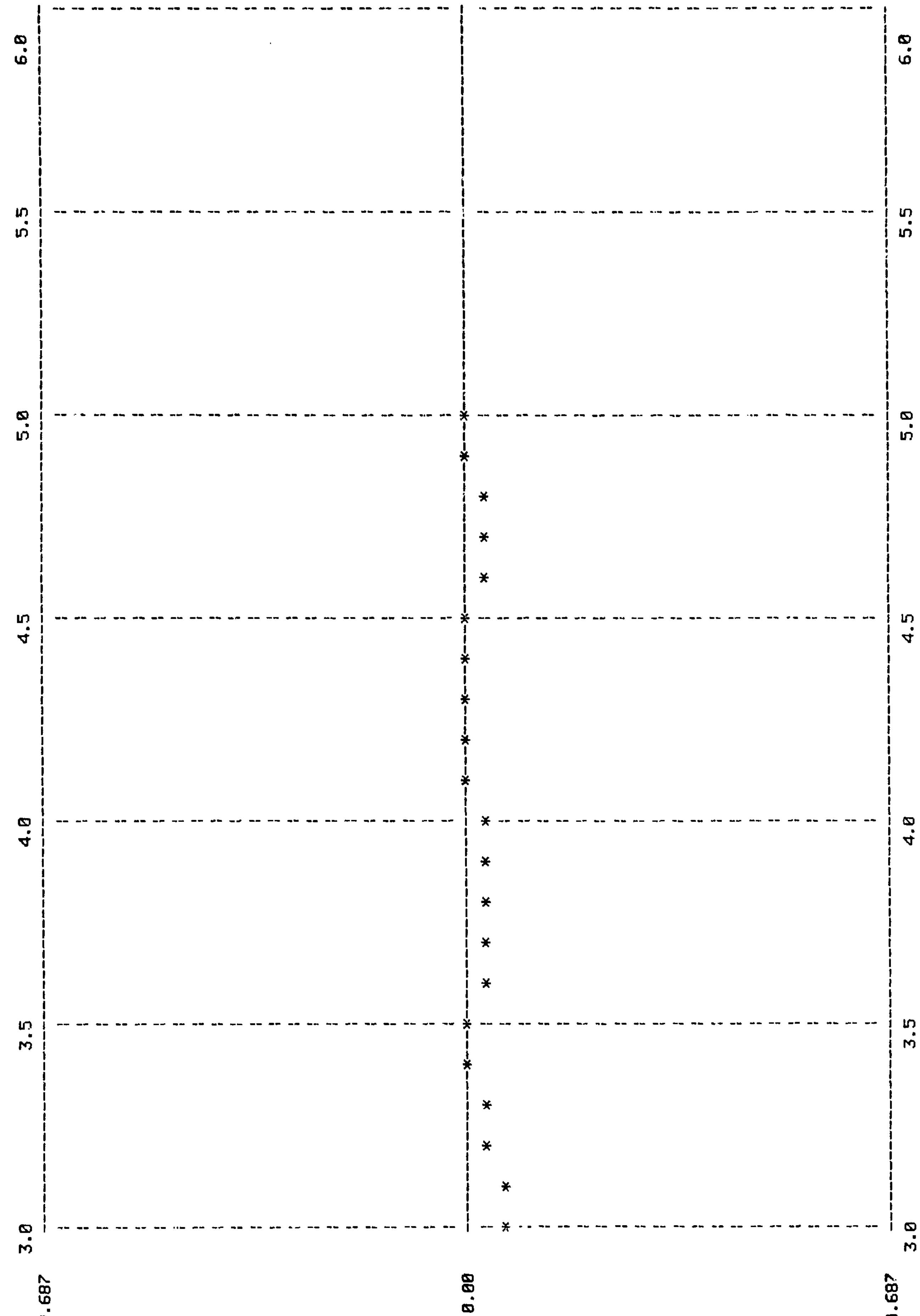




3.0
3.5
4.0
4.5
5.0
5.5
6.0
2.12
0.00
-2.12

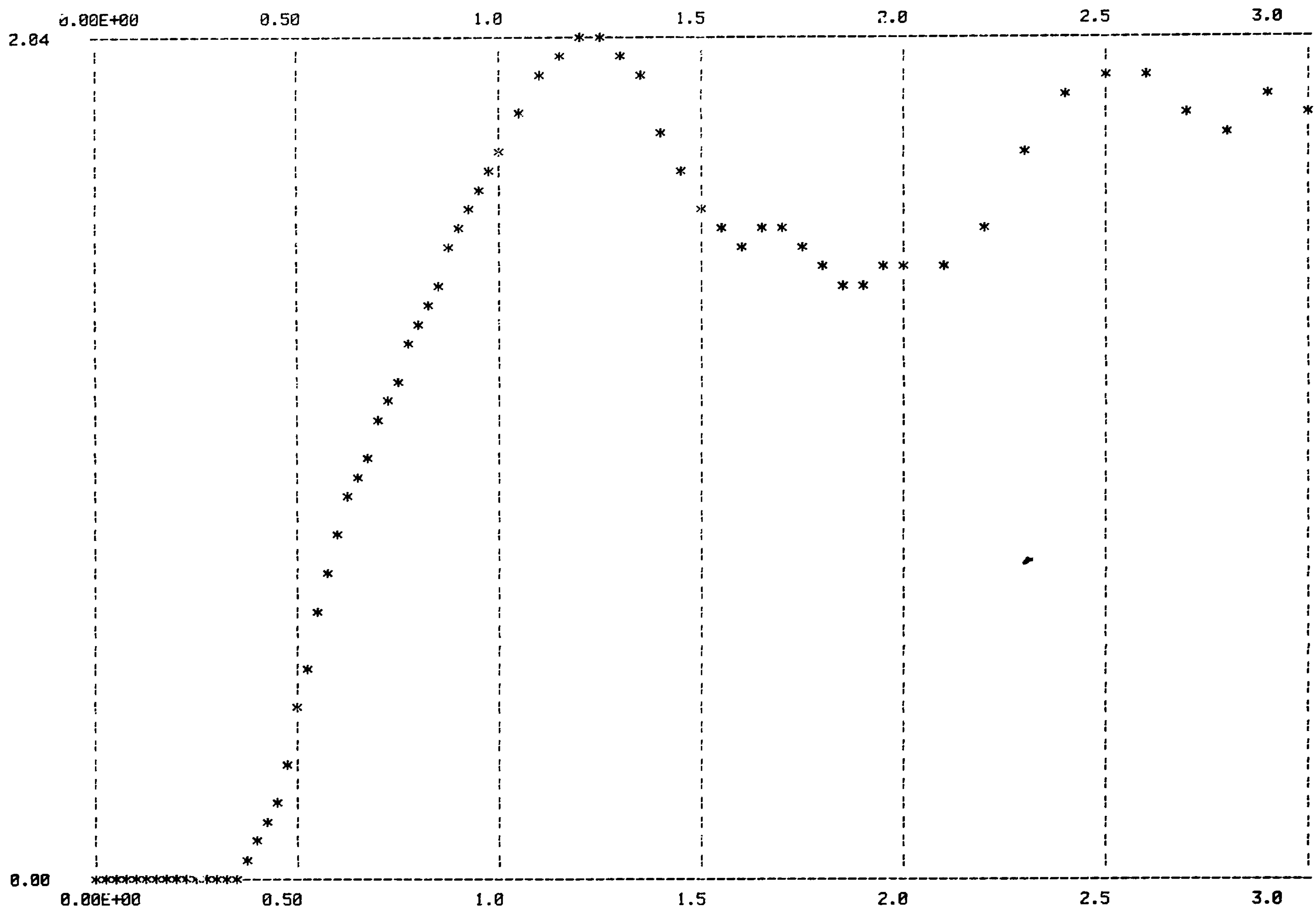
VELOCITY RESPONSE OF STRUCTURAL NODE 10, FREEDOM NUMBER 3:

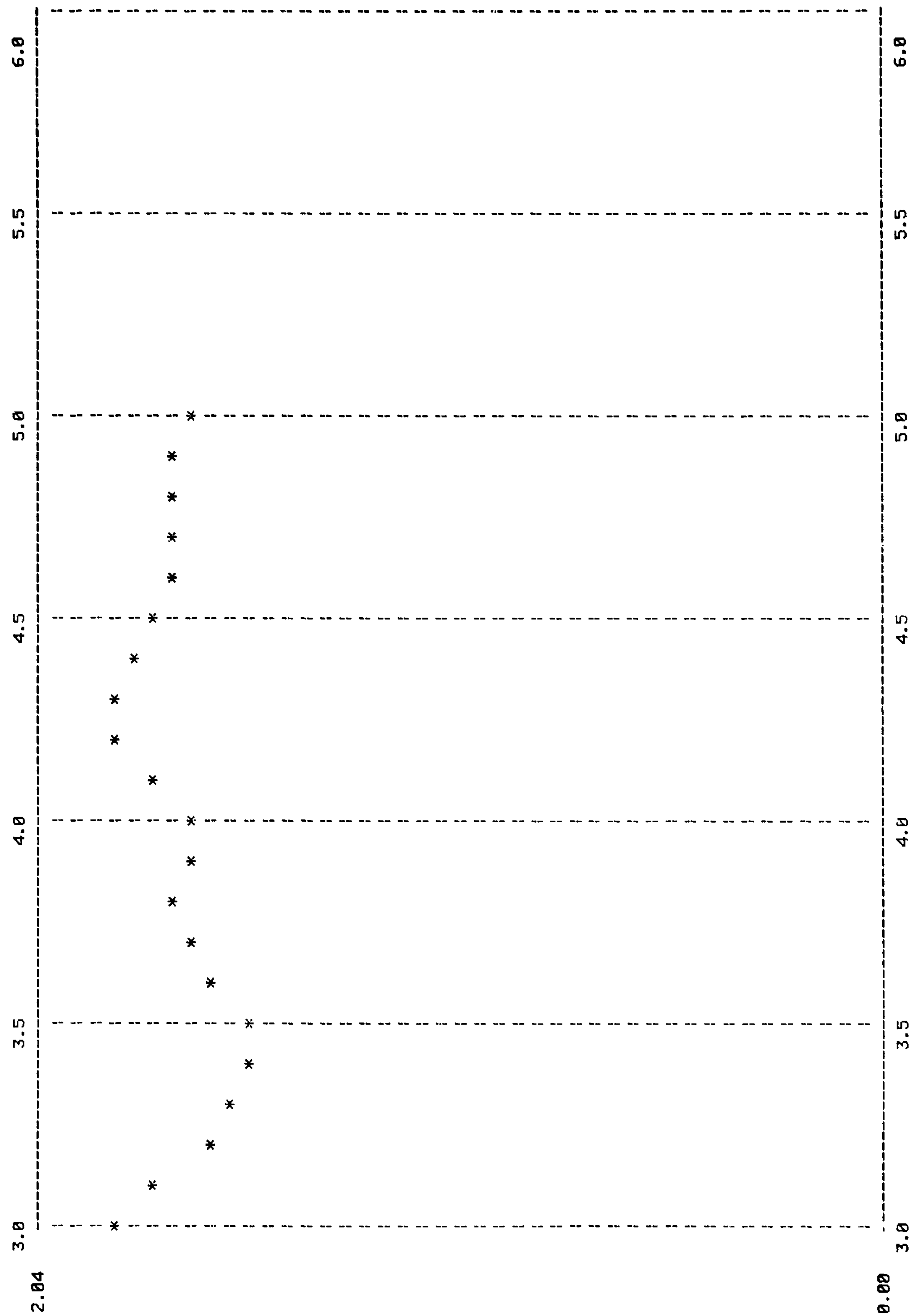




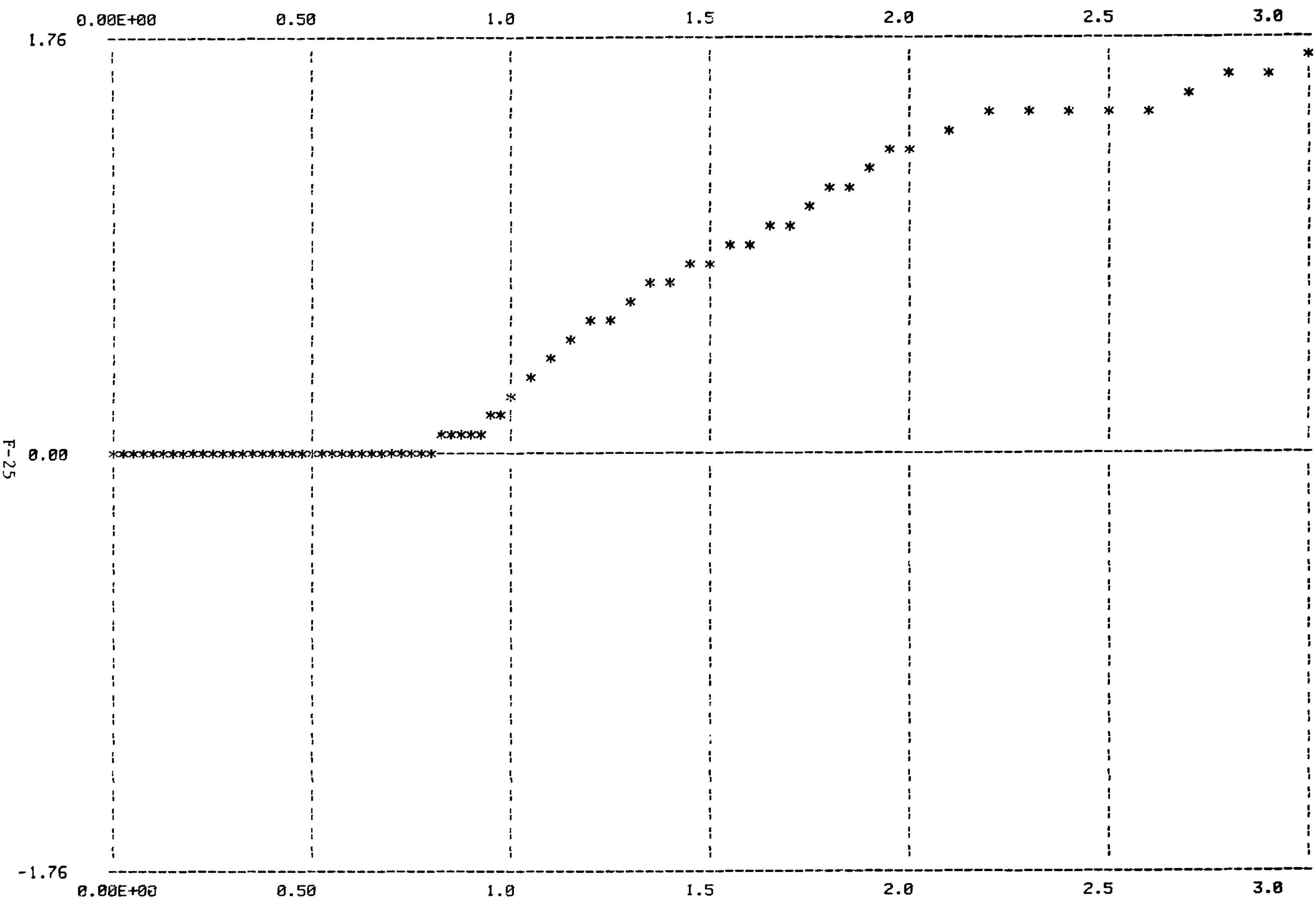
3.0
3.5
4.0
4.5
5.0
5.5
6.0
0.687
0.00
-0.687

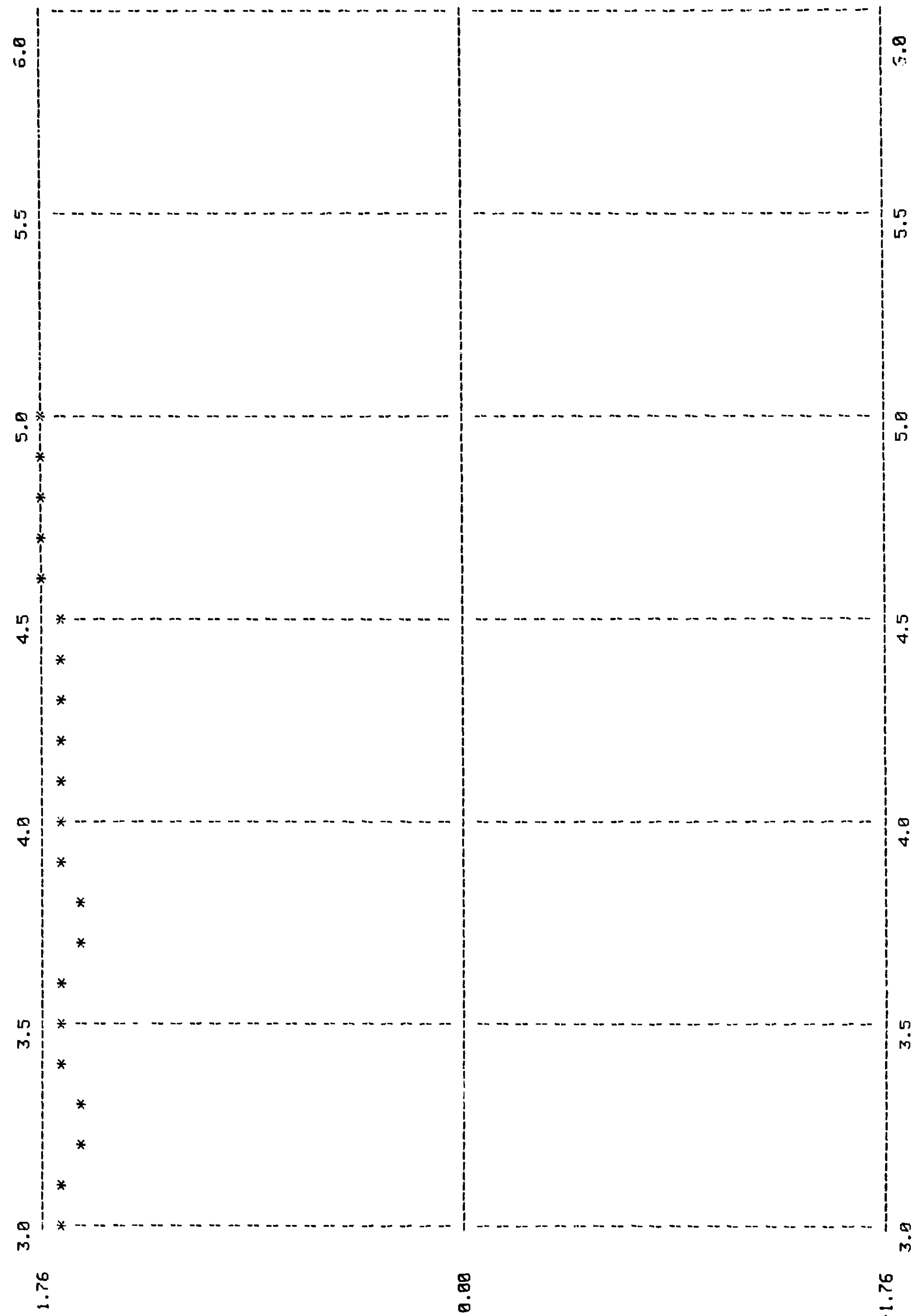
VELOCITY RESPONSE OF STRUCTURAL NODE 10, FREEDOM NUMBER 2:



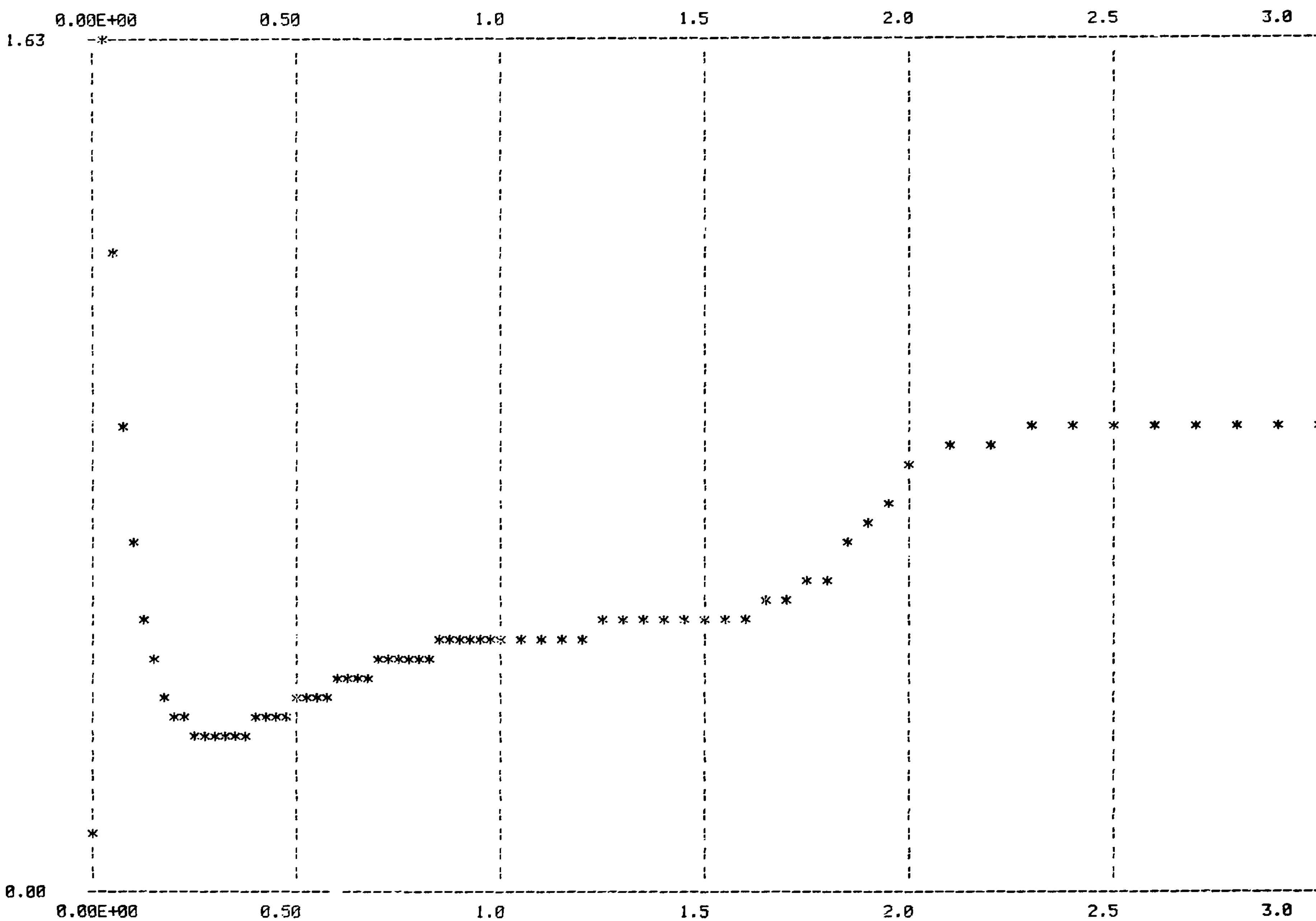

3.0
3.5
4.0
4.5
5.0
5.5
6.0
2.04
0.00

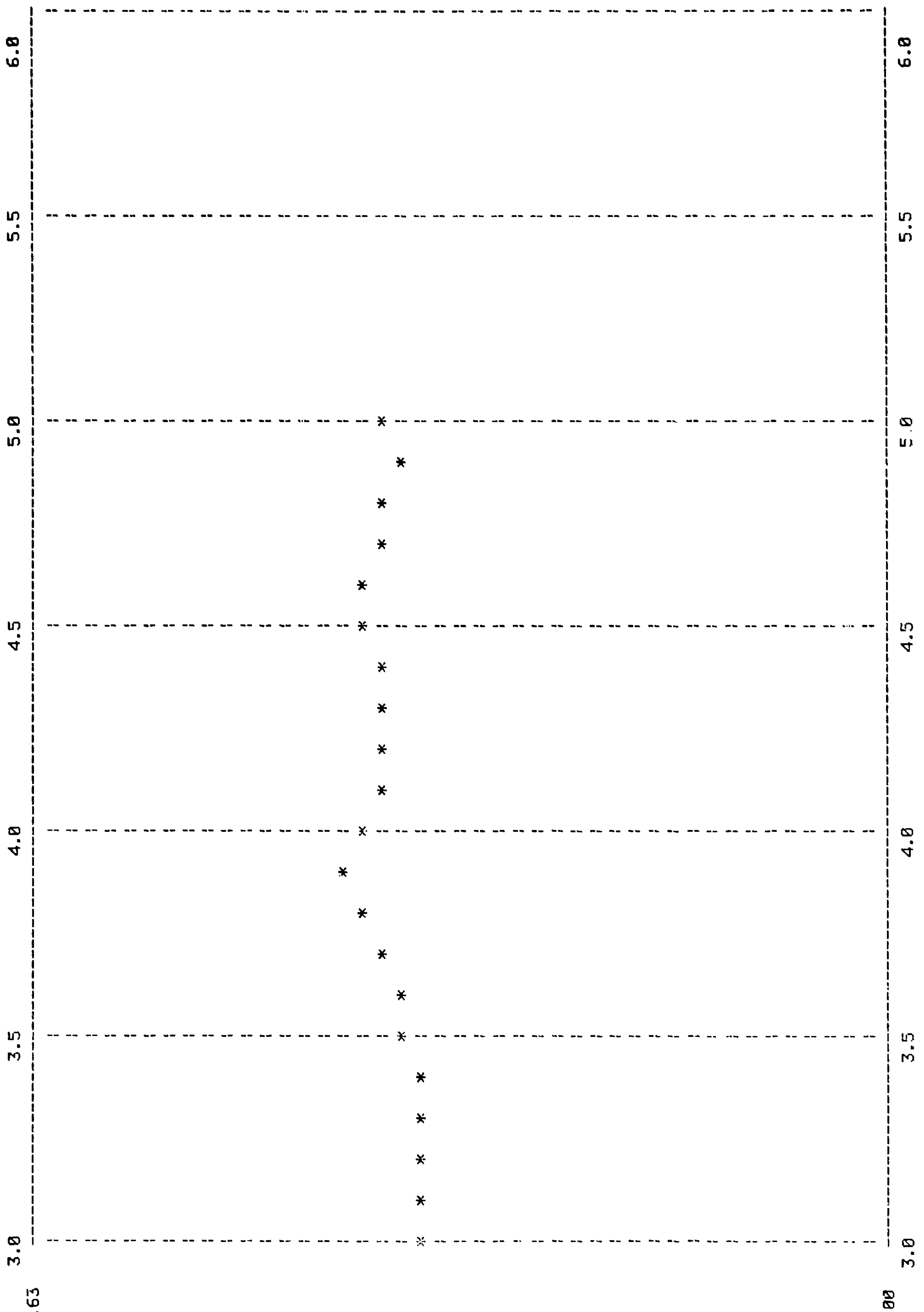
VELOCITY RESPONSE OF STRUCTURAL NODE 19, FREEDOM NUMBER 3:



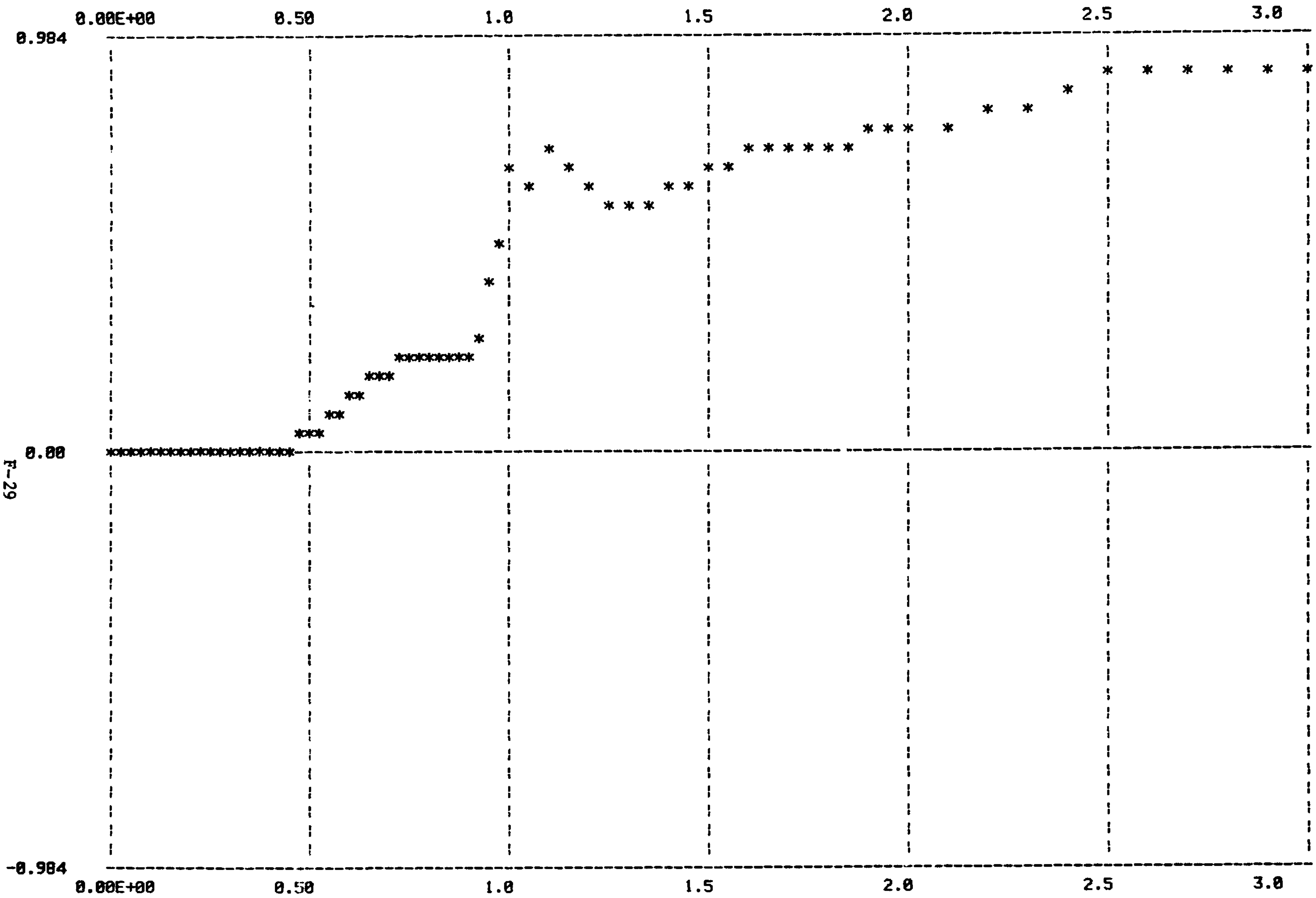

3.0
3.5
4.0
4.5
5.0
5.5
6.0
1.76
0.00
-1.76

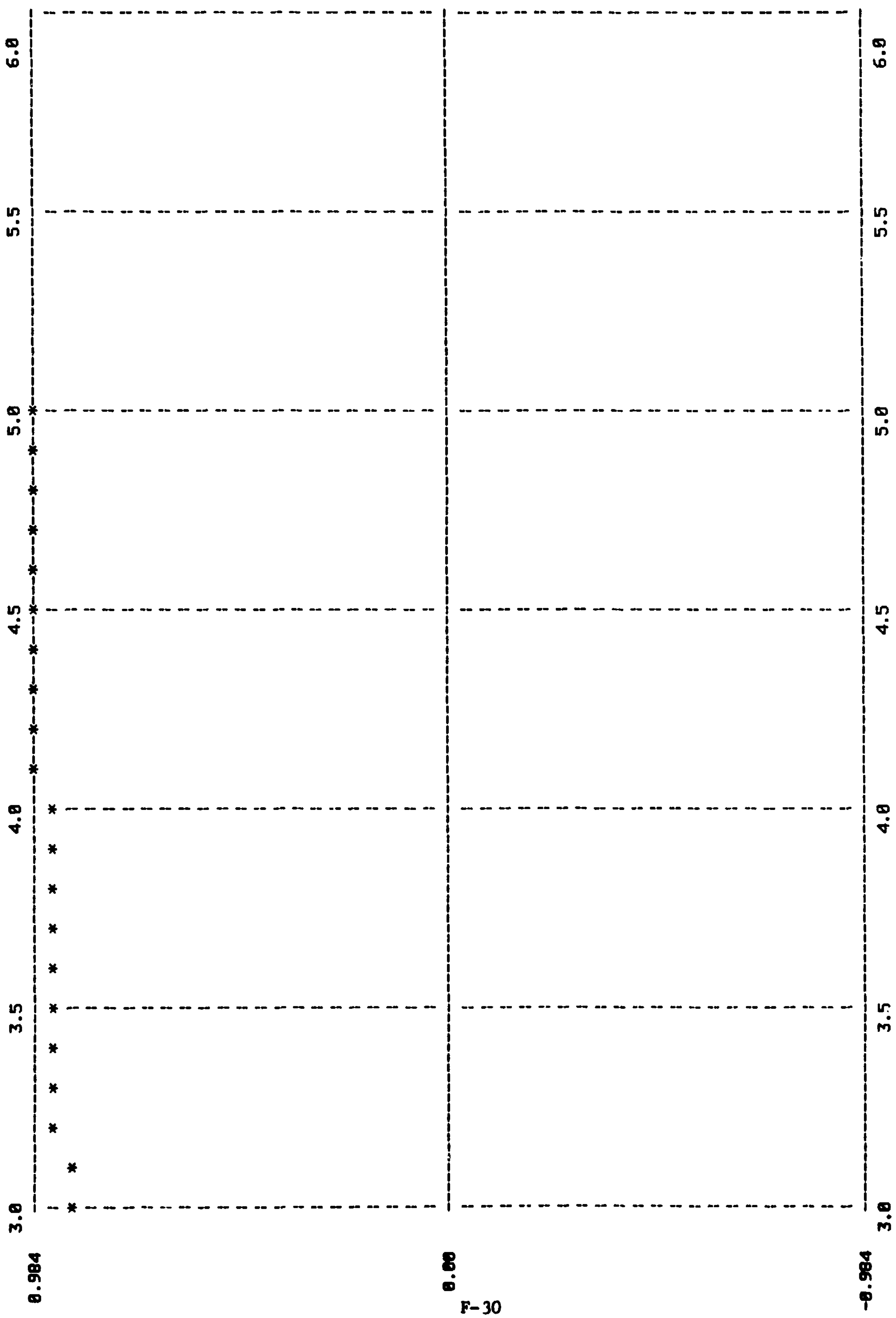
PRESSURE RESPONSE OF FLUID NODE 1:



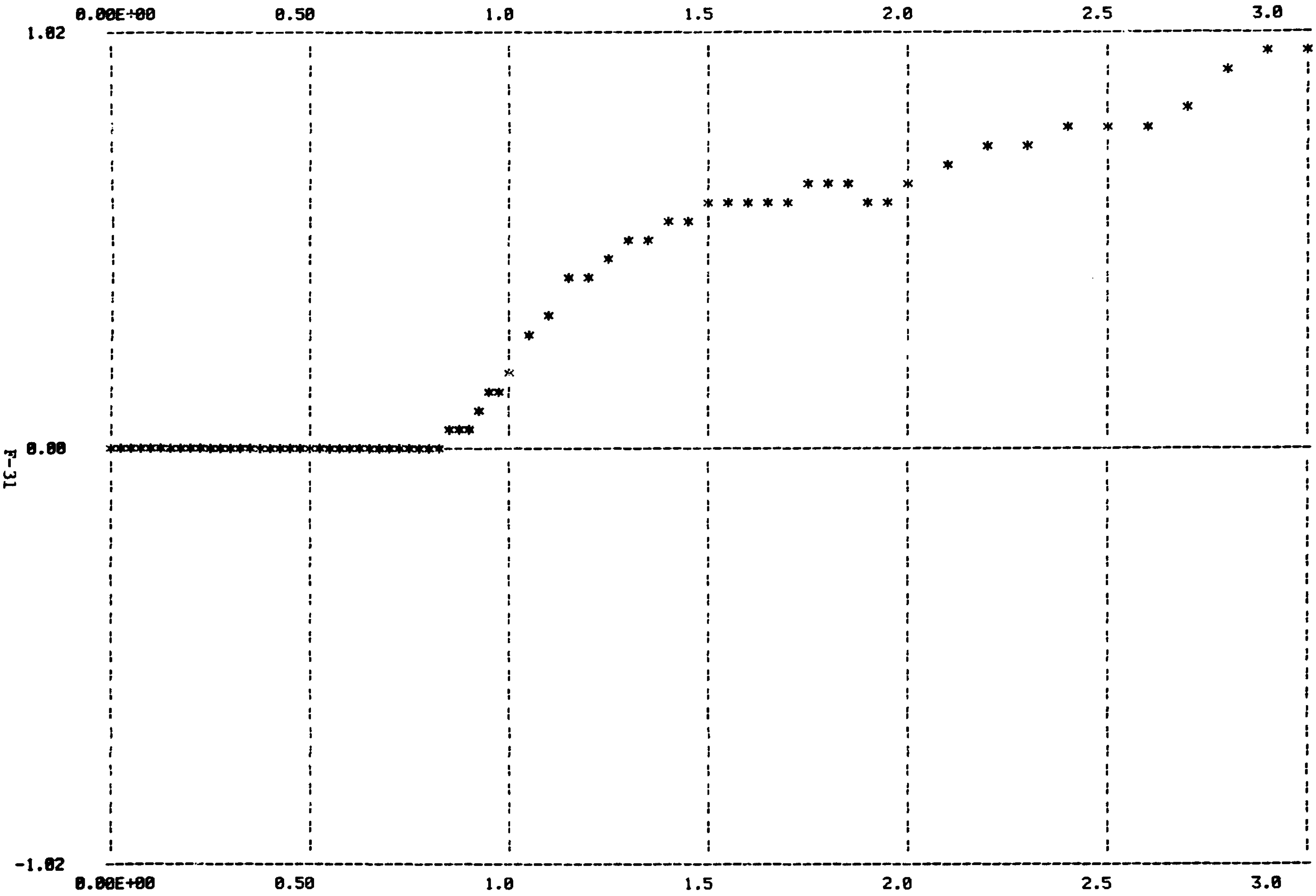

6.0
5.5
5.0
4.5
4.0
3.5
3.0
1.63
0.00

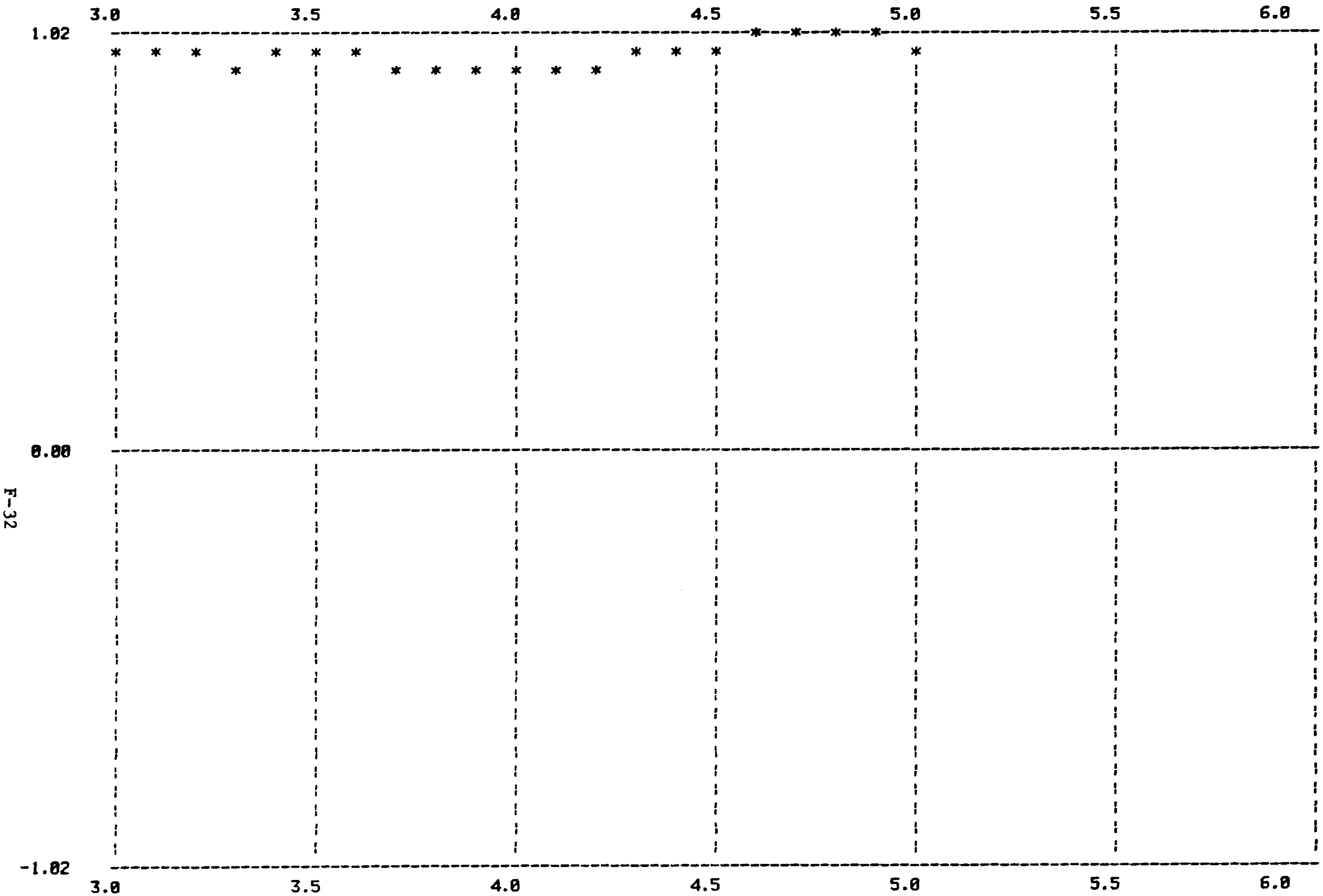
PRESSURE RESPONSE OF FLUID NODE 10:




3.0
3.5
4.0
4.5
5.0
5.5
6.0
0.984
0.00
-0.984

PRESSURE RESPONSE OF FLUID NODE 19:





+++ OPEN, 13 = FOR013 , Acc= DIRECT , Stat= SCRATCH
+++ CLOSE, 13

PSEUDO-VELOCITY SHOCK SPECTRA:

		1	2	3	4	5	6	7	8	9	10
	F	0.00000E+00	0.25000E-01	0.50000E-01	0.75000E-01	0.10000E+00	0.12500E+00	0.15000E+00	0.17500E+00	0.20000E+00	0.22500E+00
1/3	S	0.00000E+00	0.12997E+01	0.18310E+01	0.19129E+01	0.19723E+01	0.20281E+01	0.21763E+01	0.22159E+01	0.22183E+01	0.22098E+01
10/3	S	0.00000E+00	0.42513E-01	0.84574E-01	0.12574E+00	0.16556E+00	0.20363E+00	0.25815E+00	0.32501E+00	0.39981E+00	0.49739E+00
10/2	S	0.00000E+00	0.10906E+01	0.16855E+01	0.16959E+01	0.17338E+01	0.16898E+01	0.16147E+01	0.16545E+01	0.16959E+01	0.17254E+01
19/3	S	0.00000E+00	0.84361E+00	0.14356E+01	0.16061E+01	0.15306E+01	0.14717E+01	0.14034E+01	0.13271E+01	0.12553E+01	0.12009E+01

		11	12	13	14	15	16	17	18	19	20
	F	0.25000E+00	0.27500E+00	0.30000E+00	0.32500E+00	0.35000E+00	0.37500E+00	0.40000E+00	0.42500E+00	0.45000E+00	0.47500E+00
1/3	S	0.22133E+01	0.21915E+01	0.21484E+01	0.20949E+01	0.20151E+01	0.19286E+01	0.19149E+01	0.19086E+01	0.19028E+01	0.18963E+01
10/3	S	0.58027E+00	0.65643E+00	0.72682E+00	0.79727E+00	0.86301E+00	0.91530E+00	0.96104E+00	0.99818E+00	0.10399E+01	0.10744E+01
10/2	S	0.17551E+01	0.17786E+01	0.17912E+01	0.17905E+01	0.17764E+01	0.17595E+01	0.18044E+01	0.18899E+01	0.19320E+01	0.19911E+01
19/3	S	0.11514E+01	0.10983E+01	0.10410E+01	0.98543E+00	0.93036E+00	0.87506E+00	0.82726E+00	0.78822E+00	0.75531E+00	0.72635E+00

		21	22	23	24	25	26	27	28	29	30
	F	0.50000E+00	0.52500E+00	0.55000E+00	0.57500E+00	0.60000E+00	0.62500E+00	0.65000E+00	0.67500E+00	0.70000E+00	0.72500E+00
1/3	S	0.18896E+01	0.18830E+01	0.18764E+01	0.18695E+01	0.18616E+01	0.18543E+01	0.18481E+01	0.19934E+01	0.20958E+01	0.21322E+01
10/3	S	0.11002E+01	0.11239E+01	0.11571E+01	0.11677E+01	0.11606E+01	0.11757E+01	0.11589E+01	0.11621E+01	0.11497E+01	0.11465E+01
10/2	S	0.21148E+01	0.22644E+01	0.24653E+01	0.26602E+01	0.27395E+01	0.27068E+01	0.26816E+01	0.25395E+01	0.23012E+01	0.20701E+01
19/3	S	0.70039E+00	0.67618E+00	0.65372E+00	0.63444E+00	0.61445E+00	0.59821E+00	0.58061E+00	0.56700E+00	0.55162E+00	0.53895E+00

		31	32	33	34	35	36	37	38	39	40
	F	0.75000E+00	0.77500E+00	0.80000E+00	0.82500E+00	0.85000E+00	0.87500E+00	0.90000E+00	0.92500E+00	0.95000E+00	0.97500E+00
1/3	S	0.21982E+01	0.21564E+01	0.21276E+01	0.20941E+01	0.20235E+01	0.20132E+01	0.19034E+01	0.18849E+01	0.18323E+01	0.17879E+01
10/3	S	0.11346E+01	0.11362E+01	0.11438E+01	0.11479E+01	0.11416E+01	0.11436E+01	0.11437E+01	0.11351E+01	0.11206E+01	0.11206E+01
10/2	S	0.19397E+01	0.16563E+01	0.14811E+01	0.13501E+01	0.12832E+01	0.11957E+01	0.11160E+01	0.10805E+01	0.10628E+01	0.10429E+01
19/3	S	0.52703E+00	0.51387E+00	0.50294E+00	0.49354E+00	0.48324E+00	0.47208E+00	0.46400E+00	0.45676E+00	0.44086E+00	0.44032E+00

		41	42	43	44	45	46	47	48	49	50
	F	0.10000E+01	0.10250E+01	0.10500E+01	0.10750E+01	0.11000E+01	0.11250E+01	0.11500E+01	0.11750E+01	0.12000E+01	0.12250E+01
1/3	S	0.17671E+01	0.17573E+01	0.17280E+01	0.17328E+01	0.17077E+01	0.17058E+01	0.16958E+01	0.16865E+01	0.17199E+01	0.17733E+01
10/3	S	0.11136E+01	0.11001E+01	0.10802E+01	0.10695E+01	0.10614E+01	0.10484E+01	0.10676E+01	0.10631E+01	0.10521E+01	0.10692E+01
10/2	S	0.10274E+01	0.10102E+01	0.99307E+00	0.97872E+00	0.96282E+00	0.94739E+00	0.93467E+00	0.92067E+00	0.90550E+00	0.89483E+00
19/3	S	0.43115E+00	0.42533E+00	0.45042E+00	0.48196E+00	0.49572E+00	0.53295E+00	0.52617E+00	0.52938E+00	0.53363E+00	0.49073E+00

		51	52	53	54	55	56	57	58	59	60
	F	0.12500E+01	0.12750E+01	0.13000E+01	0.13250E+01	0.13500E+01	0.13750E+01	0.14000E+01	0.14250E+01	0.14500E+01	0.14750E+01
1/3	S	0.19317E+01	0.20119E+01	0.19824E+01	0.18517E+01	0.18143E+01	0.18068E+01	0.17082E+01	0.16845E+01	0.16514E+01	0.16355E+01
10/3	S	0.10460E+01	0.99032E+00	0.99714E+00	0.97172E+00	0.95411E+00	0.93672E+00	0.88445E+00	0.86135E+00	0.86929E+00	0.84635E+00
10/2	S	0.88312E+00	0.87039E+00	0.85773E+00	0.84851E+00	0.83845E+00	0.82759E+00	0.81596E+00	0.80637E+00	0.79834E+00	0.78967E+00
19/3	S	0.49809E+00	0.45509E+00	0.42375E+00	0.39761E+00	0.37303E+00	0.35758E+00	0.35016E+00	0.34363E+00	0.33999E+00	0.33596E+00

		61	62	63	64	65	66	67	68	69	70
	F	0.15000E+01	0.15250E+01	0.15500E+01	0.15750E+01	0.16000E+01	0.16250E+01	0.16500E+01	0.16750E+01	0.17000E+01	0.17250E+01
1/3	S	0.15883E+01	0.15771E+01	0.15701E+01	0.15667E+01	0.15622E+01	0.15567E+01	0.15502E+01	0.15427E+01	0.15341E+01	0.15246E+01
10/3	S	0.79541E+00	0.77458E+00	0.75886E+00	0.75650E+00	0.74120E+00	0.71079E+00	0.69491E+00	0.67928E+00	0.66397E+00	0.64906E+00
10/2	S	0.78300E+00	0.89620E+00	0.10957E+01	0.13489E+01	0.14185E+01	0.16643E+01	0.17001E+01	0.16452E+01	0.17143E+01	0.14793E+01
19/3	S	0.33156E+00	0.32680E+00	0.32168E+00	0.31623E+00	0.31046E+00	0.30442E+00	0.29811E+00	0.29462E+00	0.29615E+00	0.28802E+00

		71	72	73	74	75	76	77	78	79	80
	F	0.17500E+01	0.17750E+01	0.18000E+01	0.18250E+01	0.10500E+01	0.18750E+01	0.19000E+01	0.19250E+01	0.19500E+01	0.19750E+01
1/3	S	0.16076E+01	0.16685E+01	0.17015E+01	0.16541E+01	0.16882E+01	0.16412E+01	0.15784E+01	0.15746E+01	0.14925E+01	0.14622E+01
10/3	S	0.63780E+00	0.63047E+00	0.62340E+00	0.61665E+00	0.61024E+00	0.60419E+00	0.59851E+00	0.59319E+00	0.58823E+00	0.58361E+00
10/2	S	0.14237E+01	0.13379E+01	0.13133E+01	0.11896E+01	0.10336E+01	0.99370E+00	0.91779E+00	0.81355E+00	0.69940E+00	0.65059E+00
19/3	S	0.28438E+00	0.28056E+00	0.27656E+00	0.27242E+00	0.26815E+00	0.26377E+00	0.25932E+00	0.25481E+00	0.25026E+00	0.24570E+00

		81	82	83	84	85	86	87	88	89	90
	F	0.20000E+01	0.20250E+01	0.20500E+01	0.20750E+01	0.21000E+01	0.21250E+01	0.21500E+01	0.21750E+01	0.22000E+01	0.22250E+01
1/3	S	0.14537E+01	0.14445E+01	0.14347E+01	0.14241E+01	0.14204E+01	0.14178E+01	0.14147E+01	0.14112E+01	0.14071E+01	0.14025E+01
10/3	S	0.57931E+00	0.57529E+00	0.57153E+00	0.56799E+00	0.56462E+00	0.56138E+00	0.55822E+00	0.55510E+00	0.55196E+00	0.54876E+00
10/2	S	0.62323E+00	0.61517E+00	0.61004E+00	0.60471E+00	0.59919E+00	0.59349E+00	0.58762E+00	0.58158E+00	0.57538E+00	0.56903E+00
19/3	S	0.24114E+00	0.23660E+00	0.23210E+00	0.22764E+00	0.22324E+00	0.21891E+00	0.21465E+00	0.21161E+00	0.20917E+00	0.21444E+00

		91	92	93	94	95	96	97	98	99	100
	F	0.22500E+01	0.22750E+01	0.23000E+01	0.23250E+01	0.23500E+01	0.23750E+01	0.24000E+01	0.24250E+01	0.24500E+01	0.24750E+01
1/3	S	0.13974E+01	0.13962E+01	0.14752E+01	0.15224E+01	0.15623E+01	0.15437E+01	0.15097E+01	0.14686E+01	0.13394E+01	0.13301E+01
10/3	S	0.54545E+00	0.54197E+00	0.53829E+00	0.53435E+00	0.53010E+00	0.52551E+00	0.52053E+00	0.51513E+00	0.51690E+00	0.51914E+00
10/2	S	0.56254E+00	0.55593E+00	0.54918E+00	0.54232E+00	0.53535E+00	0.52828E+00	0.52341E+00	0.51892E+00	0.60200E+00	0.67083E+00
19/3	S	0.21679E+00	0.22132E+00	0.24694E+00	0.26347E+00	0.26949E+00	0.26430E+00	0.26359E+00	0.31557E+00	0.30211E+00	0.29248E+00

		101	102	103	104	105	106	107	108	109	110
	F	0.25000E+01	0.25250E+01	0.25500E+01	0.25750E+01	0.26000E+01	0.26250E+01	0.26500E+01	0.26750E+01	0.27000E+01	0.27250E+01
1/3	S	0.13203E+01	0.13303E+01	0.13163E+01	0.13140E+01	0.13114E+01	0.13084E+01	0.13051E+01	0.13015E+01	0.12976E+01	0.13102E+01
10/3	S	0.52120E+00	0.52305E+00	0.52464E+00	0.52595E+00	0.52693E+00	0.52755E+00	0.52776E+00	0.52755E+00	0.52687E+00	0.52571E+00
10/2	S	0.62808E+00	0.54535E+00	0.61601E+00	0.58067E+00	0.58935E+00	0.61589E+00	0.62622E+00	0.61955E+00	0.59586E+00	0.60086E+00
19/3	S	0.33967E+00	0.32835E+00	0.31348E+00	0.30281E+00	0.29070E+00	0.29894E+00	0.30290E+00	0.29660E+00	0.28545E+00	0.27366E+00

		111	112	113	114	115	116	117	118	119	120
	F	0.27500E+01	0.27750E+01	0.28000E+01	0.28250E+01	0.28500E+01	0.28750E+01	0.29000E+01	0.29250E+01	0.29500E+01	0.29750E+01
1/3	S	0.14795E+01	0.15695E+01	0.16241E+01	0.16553E+01	0.16862E+01	0.16200E+01	0.15559E+01	0.14273E+01	0.12923E+01	0.12343E+01
10/3	S	0.52403E+00	0.52182E+00	0.51905E+00	0.51573E+00	0.51183E+00	0.50735E+00	0.50229E+00	0.49665E+00	0.49046E+00	0.48370E+00
10/2	S	0.61803E+00	0.65417E+00	0.77253E+00	0.88372E+00	0.86409E+00	0.92184E+00	0.91253E+00	0.94861E+00	0.92000E+00	0.92502E+00
19/3	S	0.26033E+00	0.26250E+00	0.26151E+00	0.28051E+00	0.27826E+00	0.26352E+00	0.24887E+00	0.25793E+00	0.24550E+00	0.25616E+00

		121
	F	0.30000E+01
1/3	S	0.12268E+01
10/3	S	0.47642E+00
10/2	S	0.96612E+00
19/3	S	0.25662E+00

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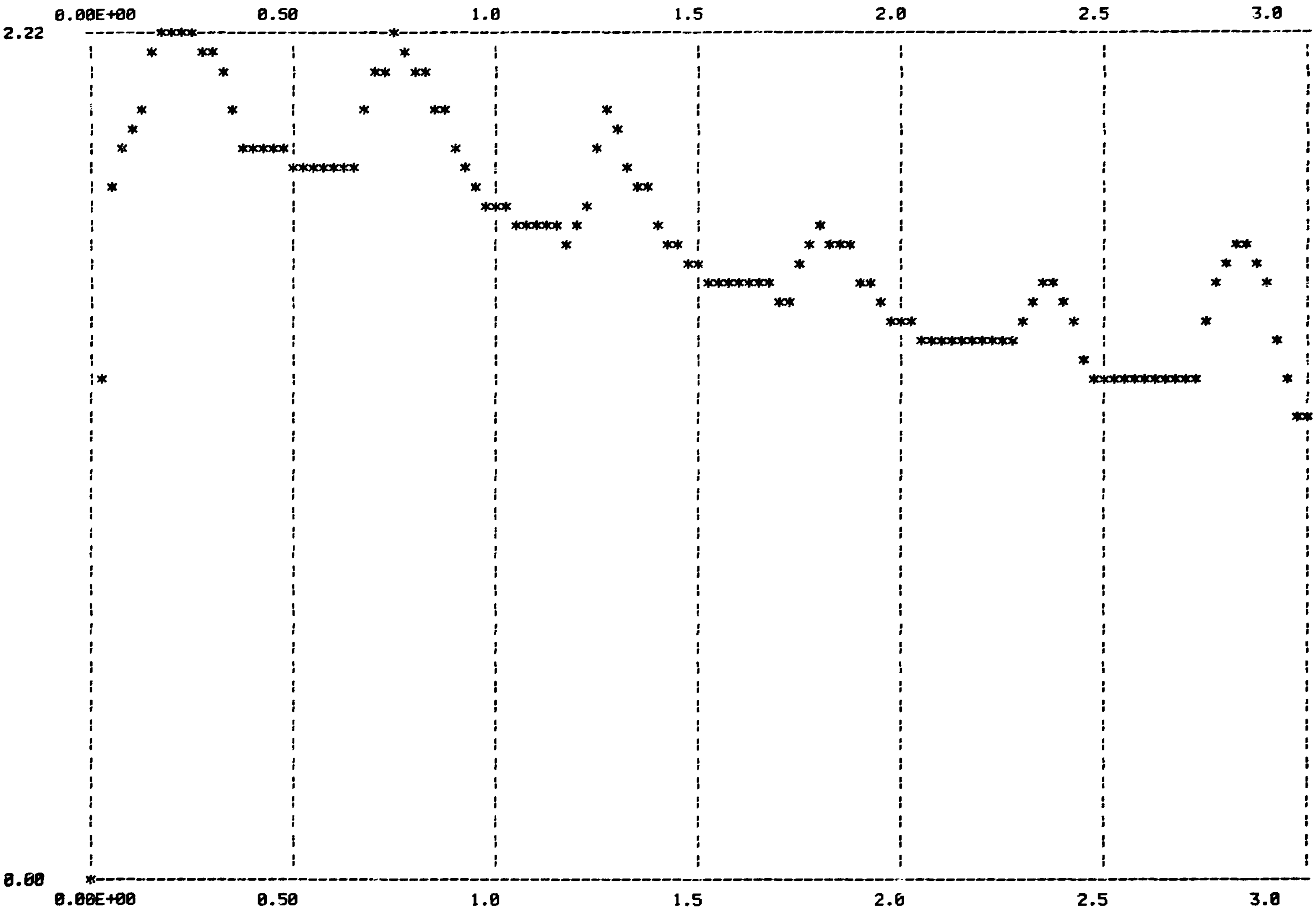

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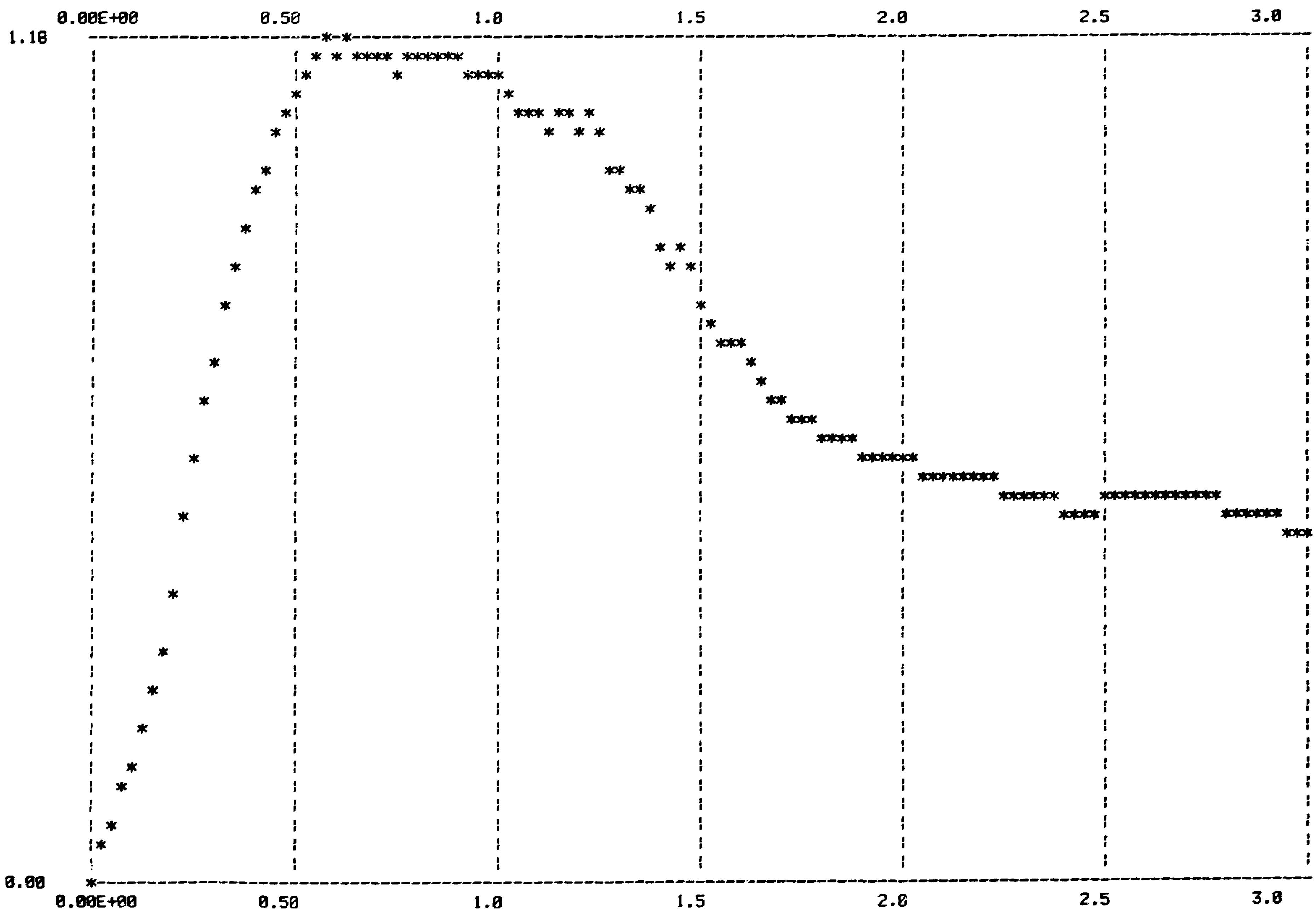

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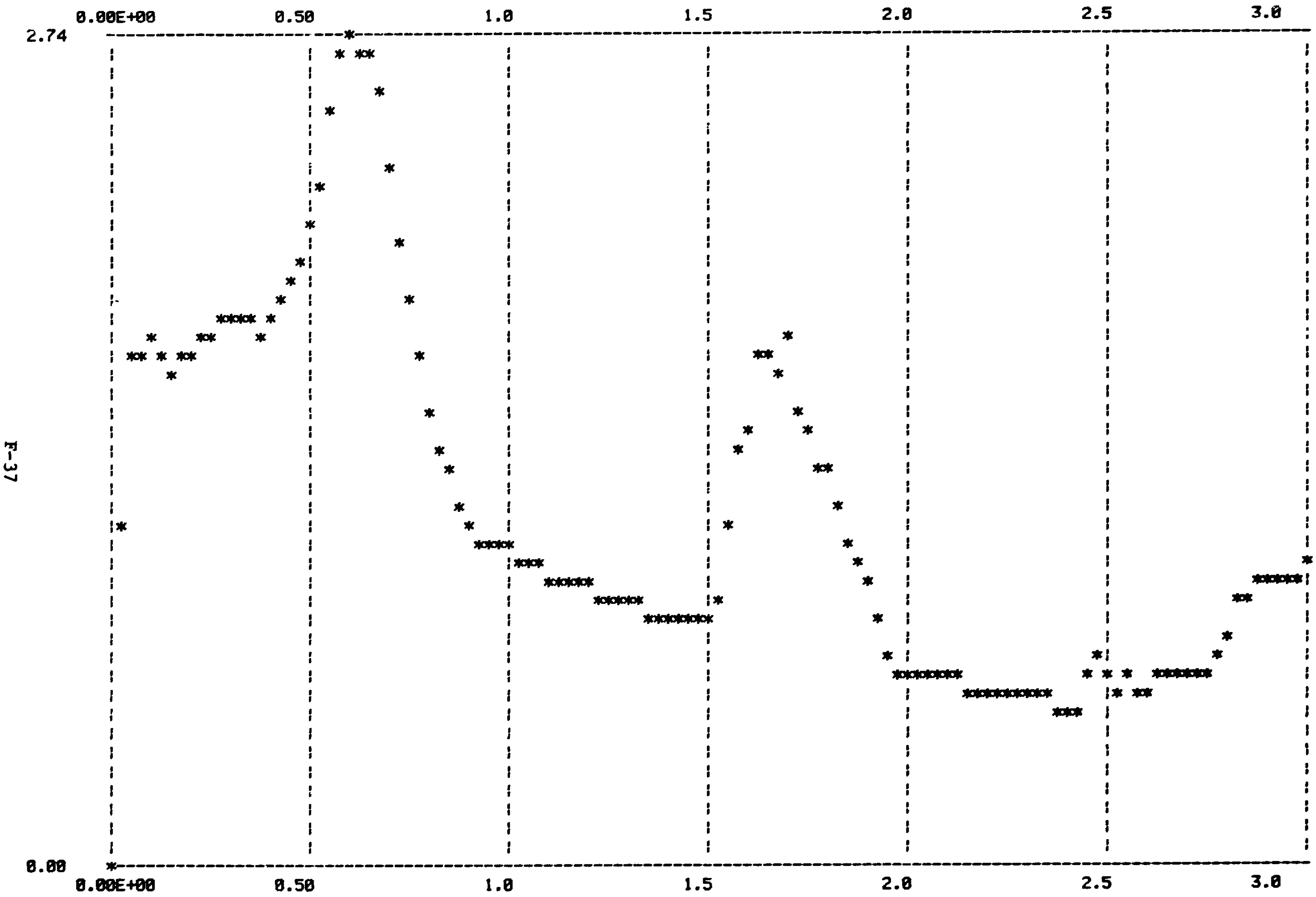

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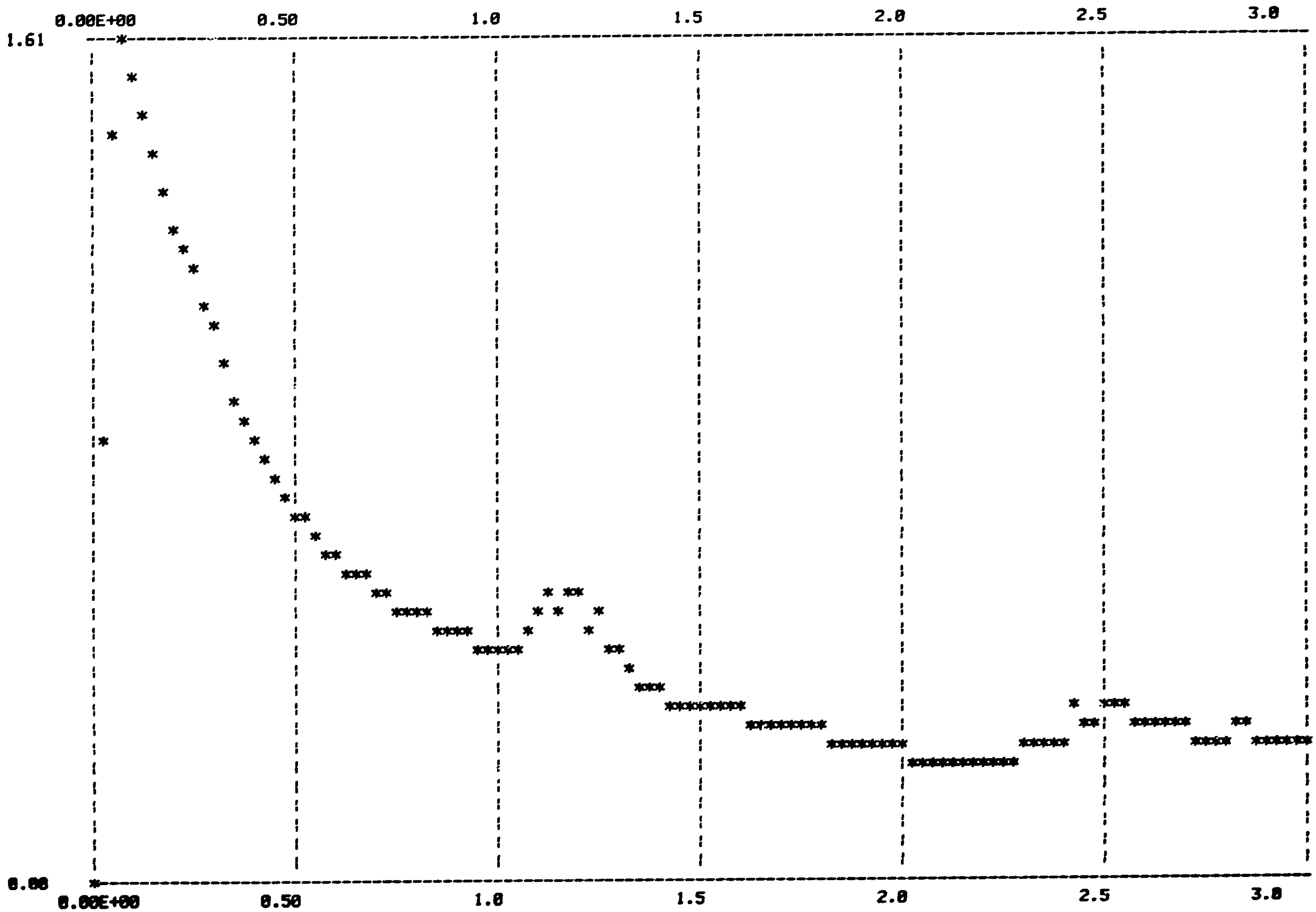

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